# ДИАЛОГ КУЛЬТУР

## материалы XIV межвузовской научно-практической конференции с международным участием

Часть I

# DIALOGUE OF CULTURES

## Proceedings of the XIV Interuniversity Scientific and Practical Conference with International Participation

Part I

Санкт-Петербург
2021

**Министерство науки и высшего образования Российской Федерации**

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**«Санкт-Петербургский государственный университет промышленных технологий и дизайна»**
**Высшая школа технологии и энергетики**

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# DIALOGUE OF CULTURES

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The proceedings include a collection of articles of the the XIV Interuniversity Scientific and Practical Conference with International Participation “Dialogue of cultures” on a wide range of topics in science and technology, business, economics and management. According to the results of the reports at the conference, the articles in English of bachelors, masters and PhD students and under the supervision of lecturers of the Department of Foreign Languages of the Higher School of Technology and Energy, as well as colleagues from other universities were published.

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# IMPACTS OF CLIMATE CHANGE AND EMPLOYMENT OF GREEN TECHHOLOGY

**Abstract.** This paper examines the ruinous effects of climate change and ways of curbing them. For the purpose of mitigating climate change, the importance and objectives of green technology are outlined.

**Keywords:** green technology, greenhouse effect, global warming, climate change, greenhouse gas.

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# ПОСЛЕДСТВИЯ ИЗМЕНЕНИЯ КЛИМАТА И ИСПОЛЬЗОВАНИЕ «ЗЕЛЕНЫХ» ТЕХНОЛОГИЙ

**Аннотация.** В этой статье рассматривается разрушительные последствия изменения климата и способы их сдерживания. Для смягчения последствий изменения климата излагаются важность и цели «зеленых» технологий.

**Ключевые слова:** зеленые технологии, парниковый эффект, глобальное потепление, изменение климата, парниковый газ.

The terms “global warming” and “climate change” are frequently used without difference in meanings. Climate change refers to varying of Earth’s temperature, humidity, air pressure, wind, clouds, and precipitations over time. Global warming affects climate change and refers particularly to the effects of greenhouse gases on earth’s normal surface temperature. The “greenhouse effect” is the warming that is caused when certain gases in Earth’s atmosphere trap heat. Climate change threatens the survival of humans and other living organisms.

Climate change has caused frequent and intense drought, horrific fires ravaging wildlife, storms, warming oceans, melting glaciers, abnormal heat, blizzards, thawing

permafrost, rising sea levels, and caused a harm to people's livelihoods and communities. Earth's atmosphere contains various gases that trap heat from the sun and prevent it from escaping back into space – these gases are referred to as greenhouse gases. When the sunlight comes to the climate, a few of it is reflected back to space and the rest is retained and re-radiated by greenhouse gasses. Most of greenhouse gasses that happen in nature are carbon dioxide, methane, and nitrous oxide. Others, such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HFCs) are only produced by human activities. If the greenhouse gases did not impact, the planet would be too cold to support life. Over time, the sum of greenhouse gases caught in Earth's atmosphere has expanded definitely, causing around the world temperatures to rise. Before this fact, natural factors have been the cause of these changes. Natural influences on the climate include solar irradiance, volcanic eruptions, ocean currents, solar variations, internal variability, changes in the orbit of the Earth, and shifts in the Earth's crust (known as plate tectonics). However, since the Industrial Revolution in the 1800s, the global temperature has increased at a tremendous rate. Burning fossil fuels, producing cement, altering how we use the soil, human activity has rapidly advanced the adverse changes to our climate. It is evident that human activities deteriorate the state of the Earth's climate. The abrupt increase in temperature accompanying this aggressive change in our climate is detrimental to humans and other living things. As consequential as the effects of climate change are expected to be on the world, the forecasted changes to our society may even be more catastrophic. Agriculture is likely to be damaged seriously – this could cause severe crop failures and livestock shortages worldwide. This shortage of food may, in turn, lead to the growth of international food markets and could cause famines, political instability, and civil unrest worldwide. In addition, experts predict serious and dramatic problems for future generations [1].

In order to take control of climate change, it is vital that we employ the use of technology that reduces the impacts of human activities on the environment and protect it. This technology is referred to as *green technology*. The most reason of green innovation is to moderate down worldwide warming and moderate the greenhouse impact. The main idea is the creation of new technologies which do not damage the natural resources and ensure their reusability. This will result into less harm to individuals, animals and the common wellbeing of our planet. It is evident that our planet starts to suffocate from all the pollution we create. The use of green technology can help immensely in mitigating pollution. Our planet is covered by refusal tips, and the air is polluted by by-products from the combustion of fossil fuels. All of this has put our planet in great danger, which requires the urgent introduction of "green" technologies around the world. More and more countries are presently turning to this sort of innovation to reduce harmful effects on the environment and protect it from unfavorable impacts. Fossil fuels are non-renewable resources and will soon be exhausted, so it is crucial for people to switch to greener alternatives. Due to green technology, people can proceed to harness the energy from nature through solar panels, wind turbines, dams, and geothermal wells, amongst many others. As a result, fossil fuels will not be depleted, greenhouse gases will be reduced, and global warming will be mitigated. Green technology can also lead to stability of prices, as these sources are

often produced locally and are not affected by geopolitical crisis and transportation costs [2].

The term “green technology” has a broad meaning. It deals with using science and technology in order to protect the environment. A lot of techniques fall under this term such as the use of green chemistry, environmental monitoring, construction of self-sufficient buildings, harnessing solar energy, production of vehicles that do not emit gases, and more. Green technology aims management and recycling waste material – it allows it to be used for beneficial purposes. This technology is used for waste management, waste incineration, wastewater treatment, and more. A lot of recyclable materials have been used to create plant fertilizer, sculptures, metals, glass, fuel, and even furniture. The most commonly recycled materials include aluminum, steel, plastic, and paper. Green technology helps purify water – the shortage of pure drinking water has been a major concern. Through the use of various technologies, a lot of campaigns launched have been successful in providing people with pure drinking water. Carbon dioxide emissions released as a result of the development of technology and production are extremely harmful to the planet. Green technologies help reduce carbon emissions and purify the air [3].

There are several advantages of using green technology. One benefit of environmental technologies is that they enable us to save plenty of energy. Through the use of conventional cars, large amounts of noxious gases are emitted into our air. Green technology like electric cars can help in mitigating air pollution. Usually, large amounts of pesticides and fertilizers are used in farming, which decimates wildlife, highly pollutes the soil, and reduces its fertility in the long run. The use of green technology can help to improve the efficiency of the fertilizers and pesticides so that less quantity of the fertilizers and pesticides will be used – this will enhance the quality of the soil. The products of green technology will replace eco-unfriendly materials like plastics and improve our environmental well-being. We cannot deny the fact that businesses are always seeking better ways to help lower the costs of their activities. To be precise, construction businesses can benefit from green energy solutions in many ways. Countless studies have shown that there is a crucial need for construction businesses to employ green technologies [4].

Green technology has some drawbacks such as high cost of implementation, insufficient information, uncertainty about performance impacts, lack of human resources and skills, etc. However, creating awareness among people, addressing these downsides, and having more skills will ensure the safety of our planet and repair the colossal damage it has suffered.

**References:**
1. Causes of climate change. URL: https://www.metoffice.gov.uk/weather/climate-change/causes-of-climate-change (date accessed: 04.05.2021).
2. US Green Technology. URL: https://www.google.com/amp/s/usgreentechnology.com/need-green-technology/%3famp (date accessed: 04.05.2021).
3. An Introduction To Green Technology. The environmental magazine. URL:https://emagazine.com/an-introduction-to-green-technology/#:~:text=Green%20technology%20refers%20to%20any,well%20as%20incorporate%20renewable%20resources (date accessed: 0.05.2021).
4. 26 Key Pros & Cons of Green Technology. URL: https://environmental-conscience.com/green-technologies-pros-cons/ (date accessed: 04.04.2021).

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## COLLOID-CHEMICAL PROPERTIES OF XANTHAN GUM

**Abstract.** Xanthan gum is a biodegradable natural polymer which dissolves in water well. The main properties of xanthan gum are the ability to increase the viscosity of solutions and the absence of negative influence on the body. The latter ensures its use in cosmetic and food industries, especially, in healthy food. Thus, the goal of the work is to study the properties of xanthan gum and the expand areas of its application.

**Keywords:** xanthan gum, viscosity, stratification, isoelectric point.

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# КОЛЛОИДНО-ХИМИЧЕСКИЕ СВОЙСТВА КСАНТАНОВОЙ КАМЕДИ

**Аннотация.** Ксантановая камедь является биоразлагаемым природным полимером, который хорошо растворяется в воде. Основными свойствами ксантановой камеди являются: способность повышать вязкость растворов и отсутствие негативного влияния на организм. Последнее обеспечивает ее использование в косметической и пищевой промышленности, особенно в здоровом питании. Таким образом, целью данной работы является изучение свойств ксантановой камеди и расширение областей ее применения.

**Ключевые слова:** ксантановая камедь, вязкость, расслоение, изоэлектрическая точка.

Xanthan gum (xanthan) is prepared by fermentation of glucose, sucrose or lactose using Xanthomonas campestris bacteria. It is a polysaccharide whose main chain consists of β-D-glucopyranose residues interconnected by a 1.4-glycosidic bond. The side chain consists of the residues of mannose, glucuronic and catalyzed pyruvic acid (Fig. 1). The number of pyruvate groups determines the viscosity of aqueous xanthan solutions [1].

Xanthan is used as a stabilizing, emulsifying, thickening agent in food, oil, pharmacological, mining industries and medicine. For food purposes, potassium, sodium or calcium salts of xanthan formed by carboxyl groups of glucuronic acid and pyruvate group are used [2].

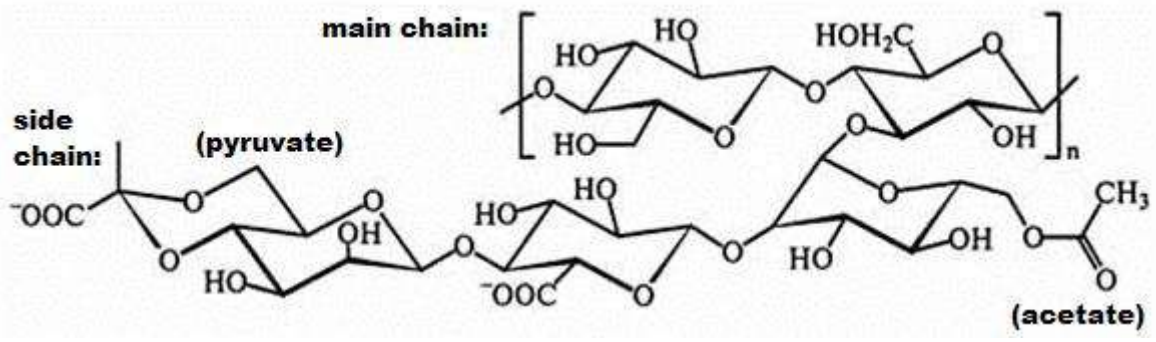


Fig. 1. Structural formula of xanthan gum

Xanthan gum is a pharmaceutical substance well known for its ability to form suspensions and gels. One of its most important properties is the ability to increase the

viscosity of the liquid. It is the most popular viscosity modifier of suspensions in medicine [3].

In this regard, the purpose of this research is to study the dependence of the properties of aqueous solutions of gums on temperature and pH level, which opens up wide possibilities for its practical use, for example, in medicine to obtain new biologically active compounds, in cosmetology, in the food industry.

The gum used in the food industry was selected for the study. IR spectra of xanthan gum were measured and showed no impurities in this xanthan gum (Fig. 2).

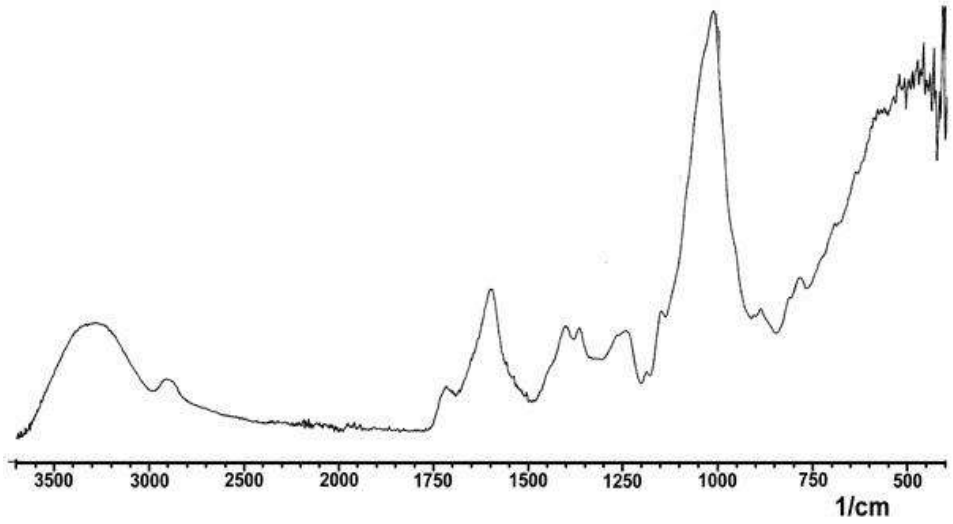


Fig. 2. IR spectrum of xanthan gum

A study of the effect of temperature on aqueous solutions of xanthan gum shows that stratification of the solution is observed at a temperature above 90 °C. As the temperature decreases, the solution returns to the single phase condition again. The behavior of the viscosity of solutions when changing temperature is standard: when heated, the viscosity of solutions decreases, and when cooled, it increases.

Studying the viscosity of xanthan solutions under various pH conditions will make it possible to understand the conformational state of macromolecules. Polymer molecules change their conformation upon contact with water, maintaining molecular weight. In water, polymer chains flatten, thereby increasing the volume of the molecule.

At concentrations above 0.5 %, the high viscosity value remains substantially unchanged in the range of pH 2 to 12, slightly decreasing at the extreme points. On the other hand, the lower the concentration, the more noticeable the effect of pH on the viscosity (Fig. 3).

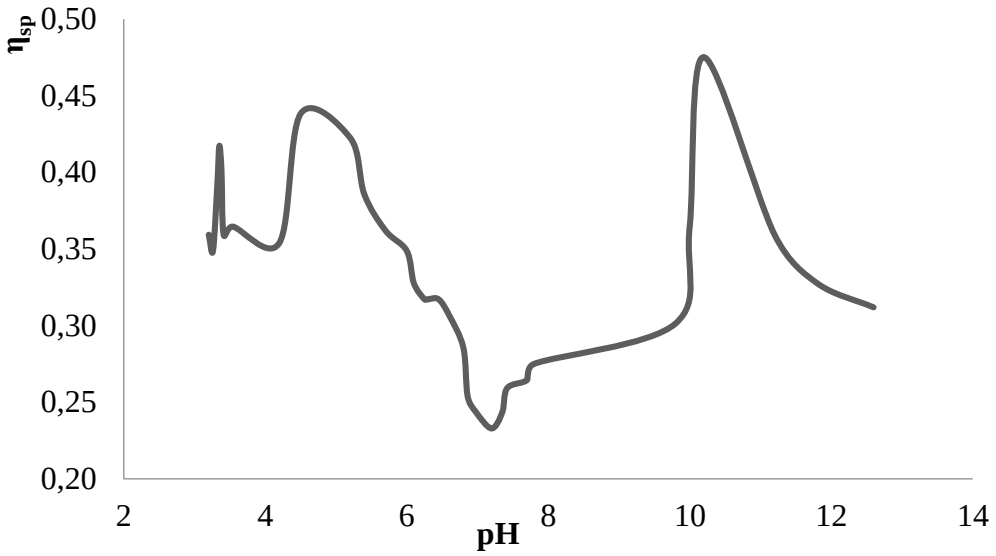


Fig. 3. The dependence of the viscosity of the gum solution on the pH of the medium.

The graph shows that the viscosity is minimal in the neutral medium, then begins to grow as the pH increases or decreases. The observed decrease in viscosity in the range of pH values close to neutral is similar in nature to the isoelectric point (IET) of amphoteric polyelectrolytes (polyampholites), in which the degree of swelling and solubility depends on the pH of the solution. The isoelectric point is the value of the pH of the solution at which the least swelling and solubility is observed, this is due to the zero average total charge of the macromolecules of the polyelectrolyte. In IET, the repulsion force between the functional groups of the polymer is minimal, the macromolecule is folded into the densest tangle and due to the minimum volume of the globule, it prevents the flow of liquid the least. The IET value does not depend on the concentration of the polyelectrolyte and is its important constant, depending on the composition of the polymer, the strength of the basic and acidic groups, the ratio of charged and neutral polar groups. The larger the acid groups in the macromolecule, the smaller the pH at the isoelectric point. In the initial gum, part of the carboxyl groups is in salt form, the more these groups, the closer the isoelectric point to pH 7, as follows from the data presented in Figure 3, the IET of xanthan gum is 7.2. As the pH decreases or increases, the macromolecule flattens and because of suppressing ionization of the ionic groups of the same name, the viscosity of the solution decreases again.

*Conclusions:*

1. An IR spectrum of xanthan gum was obtained, which showed the absence of impurities in its composition.

2. An important constant of polyampholite is determined – the isoelectric point of the gum, at which the macromolecule is folded into the densest tangle and due to the small volume of this tangle prevents the flow of liquid the least.

3. The study of the effect of the pH medium on the viscosity of xanthan gum solutions is of practical importance when using xanthan gum as a thickener in gluten-free flour. It is important to know how the solution will behave when the environment changes during the production of products.

**References:**

1. Polysaccharides: structural diversity and functional versatility / ed. by S. Dumitriu. New York: Marcel Dekker. 2005. 1224 p.
2. Saha, D., Bhattacharya, S. (2010) Hydrocolloids as thickening and gelling agents in food: a critical review. Journal of Food Science and Technology. 47, pp. 587–597.
3. Vernikovsky, V. V., Tretyakova, E. V. *Vspomogatel'nye veshchestva v peroral'nyh suspenziyah* [Adjuvants in Oral Suspensions]. *Razrabotka i registraciya lekarstvennyh sredstv* [Development and Registration of Medicines]. 2017. Vol. 2, pp. 116-123. (in Russian).

**Список литературы:**

1. Polysaccharides: structural diversity and functional versatility / ed. by S. Dumitriu. New York: Marcel Dekker. – 2005. – 1224 с.
2. Saha D., Bhattacharya S. Hydrocolloids as thickening and gelling agents in food: a critical review // Journal of Food Science and Technology. – 47. – 2010. – 2010. – С. 587-597.
3. Верниковский В. В., Третьякова Е. В. Вспомогательные вещества в пероральных суспензиях // Разработка и регистрация лекарственных средств. – 2017. – Т. 2. – С. 116-123.

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## INCREASING THE EFFICIENCY OF ENERGY SAVING IN THE ENTERPRISE THROUGH ENERGY SAVING TECHNOLOGIES

**Abstract.** This article analyzes the current situation of energy supply and identifies the potential for energy savings in enterprises. Energy saving measures are also selected.

**Key words:** electricity, energy efficiency, energy saving, energy service.

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# ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ ЭНЕРГОСБЕРЕЖЕНИЯ НА ПРЕДПРИЯТИИ ЗА СЧЁТ ЭНЕРГОСБЕРЕГАЮЩИХ ТЕХНОЛОГИЙ

**Аннотация**. В данной статье проводится анализ текущей ситуации энергоснабжения и выявление потенциала энергосбережения на предприятиях. Также подбираются мероприятия по энергосбережению.

**Ключевые слова**: электроэнергия, энергоэффективность, энергосбережение, энергосервис.

The problem of the energy industry is very acute today, since the constant development of industry and technology leads to a significant increase in energy costs and to a decrease in energy efficiency and energy saving at any enterprise [1]. Thus, the most important direction in the development of energy efficiency policy is to reduce energy consumption and increase energy efficiency of enterprises [2; 143].

In the modern world, energy service has become widespread, which is a set of measures aimed at optimizing the consumption and production of electricity at any industrial facility.

With the right approach, it is not so difficult to improve the efficiency of work execution, as well as reduce energy consumption.

The whole essence of the measures is aimed at the fact that the consumption of energy resources should be reduced, while the number of products produced will remain unchanged. Or the productivity of the enterprise should be increased, and the electricity consumption should remain at the same level.

The result of the implementation of measures to improve energy efficiency at enterprises is a significant increase in the economic effect of the enterprise, an increase in the competitiveness of the product in the world market. The reason for such changes is that the energy consumption for the production of a unit of goods decreases and, as a result, there is no urgent need to increase the price.

Another beneficial result of the implementation of energy efficiency measures is the modernization of equipment, which reduces energy consumption, as well as minimizes risks, which increases the safety of the technological process.

In order to determine the energy saving measures that can be carried out in relation to the consumed electricity, it is necessary to carry out:

1. Analysis of the situation of consumption and production of electricity. It includes two types of audit – an audit of power supply conditions and an audit of the technical condition of equipment and all production support systems of the enterprise.

An audit of energy supply conditions allows assessing the following parameters:

- the economic benefit of working with an electric energy supplier (if there was no particular choice before, today every enterprise can choose the optimal conditions for the supply of electric energy);
- conditions of pricing for electrical energy;
- the mode of consumption of electrical energy;
- control of electricity consumption.
- An audit of the technical condition of the equipment allows you to assess the following parameters:
- potential for increasing energy efficiency during modernization – equipment;
- economic feasibility of introducing energy-saving technologies;
- a number of measures to achieve economic effect;
- the timing of achieving the desired results in savings when carrying out the necessary measures.

2. Identification of the company's energy saving potential.

3. Energy saving program.

4. Energy saving measures [3; 373].

Energy efficiency and energy saving in the enterprise will depend on the correct implementation of measures, the plan of which is drawn up after a thorough analysis.

For convenience, all events can be conditionally divided into 2 main groups:

1. Mandatory measures, the implementation of which is necessary in accordance with the requirements of regulatory legal acts. This includes measures such as equipping all buildings and facilities with electricity meters and optimizing workplaces and workshops.

2. Activities that are optional, but provide economic benefits. For example, replacement of equipment [4].

In order to achieve low energy consumption in production quickly enough and with minimal costs, it is necessary to carry out the following measures, the payback period of which will be from two to three years (Table 1).

Table 1

Energy saving measures at the enterprise

| **Event** | **Potential effect** |
|---|---|
| Installation of reactive power compensation devices (UKRM) | This event allows you to get additional power and save electricity, since when the limit values of the power factor (over 150 kW) are exceeded, increasing coefficients can be applied to tariffs for transmission services. |

Continuation of Table 1

| | |
|---|---|
| Installation of variable frequency drives to control electric motors | This measure also leads to a significant reduction in electrical energy consumption, since a large share of electrical energy consumption in industry is accounted for by AC motors. This machine fork is overly energy-consuming and the VFD installation solves this problem, reduces energy consumption by optimizing the system control and minimizing the installed power. |
| Installation of electricity consumption monitoring systems | The implementation of this measure will allow you to control costs and, with proper planning of consumption, will help in optimizing energy costs. |
| Replacing the existing lighting system with a more energy efficient one | This event, in combination with the use of automatic switches in lighting systems, will help reduce energy costs by up to 70 %. |
| Coloring the room in light colors, reducing the use of personal appliances, etc. | Such not very expensive measures will also help to save money. |

Thus, the implementation of the above measures leads to the following results: reduction in the cost of purchased energy resources and, as a result, the enterprise receives an economic effect; the use of energy resources per unit of product is reduced, which leads to an increase in the competitiveness of the product in the market; due to the modernization of equipment, accidents, the possibility of equipment failure and a number of other factors are reduced [5; 42].

The implementation of these measures will lead to an improvement in the energy efficiency of the enterprise. Their implementation will lead to a reduction in energy consumption while maintaining the current production volume, or to an increase in production volumes while maintaining the current consumption of energy resources, depending on the company's plans, which, in turn, will lead to a decrease in energy costs.

**References:**

1. Bolycheva, E. A. *Otzenka sostoyanya i razvitya malogo biznesa v Kurskoy oblasti* [Assessment of the state and development of small business in the Kursk region]. *Paradigmaticheskye osnovy gosudarstvennogo upravlenya: sotzial'no-ekonomicheskaya perspektiva* [Paradigmatic foundations of public administration: a socio-economic perspective]: *Sbornik nauchnych statey mezhdunarodnoy*

*nauchnoy konferentzii* [Collection of scientific articles of the international scientific conference]. URL: https://cyberleninka.ru/article/n/prostranstvennoe-razvitie-kurskoy-oblasti-v-tselyah-effektivnogo-gosudarstvennogo-upravleniya (date accessed: 24.03.21).
2. Laptev, R. A. *Issledovanya po sotrudnichestvu tamozhennych sluzhb v ramkakh integratzii EAES v mirovuyu ekonomiku v kachestve nezavisimoy temy* [Research on cooperation of customs services within the framework of the EAEU integration into the world economy as an independent subject]. *Sotzial'no-ekonomicheskye i pravovye osnovy innovatzionnogo razvitya* [Socio-economic and legal foundations of innovative development, a collection of scientific articles]: *Sbornik nauchnych statey* [Collection of scientific articles]. Penza. 2018, pp. 143-150 (in Russian).
3. Charyshkina, A. V. *Osobennost' ekonomiki v energeticheskoy otrasli* [Feature of the economy in the energy industry]. *Molodoy uchenyy* [Young scientist]. Kazan'. 2017. № 12, pp. 373-376 (in Russian).
4. Larin, D. *Kak snizit' zatraty na elektroenergiyu na predpriyatii?* Energomart. URL: https://en-mart.com/zatraty-na-elektroenergiyu-na-predpriyatii/ (date accessed: 29.03.21).
5. Golovin, A. A. *Analiz politiki importozamezchenya v promyshlennom sektore ekonomiki Rossii* [Analysis of the import substitution policy in the industrial sector of the Russian economy] *Ekonomiko-organizatzionnye voprosy vneshneekonomicheskoy deyatel'nosty* [Economic and organizational issues of foreign economic activity: Collection of scientific articles]: *Sbornik nauchnych statey* [Collection of scientific articles]. SPb. 2020, pp. 42-49 (in Russian).

**Список литературы:**

1. Болычева Е. А. *Оценка состояния и развития малого бизнеса в Курской области. Парадигматические основы государственного управления: социально*-экономическая перспектива: сборник науч. ст. международной научной конференции. URL: https://cyberleninka.ru/article/n/prostranstvennoe-razvitie-kurskoy-oblasti-v-tselyah-effektivnogo-gosudarstvennogo-upravleniya (дата обращения: 24.03.21).
2. Лаптев Р. А. Исследования по сотрудничеству таможенных служб в рамках интеграции ЕАЭС в мировую экономику в качестве независимой темы // Социально-экономические и правовые основы инновационного развития: сборник науч. ст. – Пенза, 2018. – С. 143-150.
3. Чарышкина А. В. Особенность экономики в энергетической отрасли // Молодой ученый. – Казань, 2017. – № 12. – С. 373-376.
4. Ларин Д. *Как снизить затраты на электроэнергию на предприятии? Энергомарт.* URL: https://en-mart.com/zatraty-na-elektroenergiyu-na-predpriyatii/ (дата обращения: 29.03.21).
5. Головин А. А. Анализ политики импортозамещения в промышленном секторе экономики России // Экономико-организационные вопросы внешнеэкономической деятельности: сборник науч. ст. – СПб, 2020. – С. 42-49.

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# HYDROGEN STORAGE

**Abstract.** An important problem in hydrogen energy is the storage of hydrogen. In fact, storing hydrogen is very expensive, more expensive than producing it. Storage also has a number of specific conditions, consisting of: low temperature, high pressure, and a number of other parameters. Storage requires reliability and security. Our energy industry has learned to store hydrogen in gaseous form under pressure and in liquid form.

**Keywords:** Hydrogen, isolation, hydride, conversion, liquefaction, hydrolysis, dissociation.

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# ХРАНЕНИЕ ВОДОРОДА

**Аннотация.** Важная проблема в водородной энергетике – хранение водорода, оно дороже, чем его производство. Хранение также имеет ряд определенных условий: низкая температура, высокое давление и другие параметры. Хранение требует надежности и безопасности. Наша энергетика научилась хранить водород: 1) в газообразном виде под давлением, 2) в жидком виде, 3) в твердых носителях.

**Ключевые слова**: водород, изоляция, гидрид, конверсия, сжижение, гидролиз, диссоциация.

The easiest and most effortless way to store hydrogen is in a gas – like form under pressure. This technology is not very expensive, but it needs strong cylinders. The storage of hydrogen by this method did not turn out to be a big problem, because the principle of storage, structure and technical component, has long been worked out in the storage of natural gas.

Storage of hydrogen in gaseous form is classified into ground and underground storage.

The most affordable and inexpensive method for large – scale storage of hydrogen is underground caves. There are different types of caves: salt caves and

aquifer structures. The salt is arranged in the form of plates that are several hundred meters thick. They practically do not pass air and water. Aquifers are located in well-absorbed geological levels. The gas is introduced into the layer in which the water was located, where it accumulates. This method is only used in special geological conditions, and is only available in certain regions.

Ground storage is different in size, it is much smaller than underground caves. A big positive feature of the containers, they do not pass hydrogen, leakage is practically excluded. Containers with a standard pressure of 20 MPa are usually used. There are also higher pressure tanks (>20 MPa) and low pressure spherical tanks (1.2-1.6 MPa). Cheap, fairly practical material-steel, but quite heavy, is often used in the manufacture of tanks for storing hydrogen. Some are made of aluminum, which is much lighter than containers made of steel [1].

Storage of hydrogen in liquefied form, easier to operate, as a container with liquid hydrogen, lighter than containers under pressure. Liquefied hydrogen has been used as fuel in space technology for many years. But the storage technology is complex, since hydrogen at a temperature of 20.25 K passes into the liquid phase, and it is necessary to eliminate evaporation by carefully isolating it. But evaporation is inevitable, and the tanks lose energy, about 3 % per day. Therefore, combined insulation is used. That is, vacuum and conventional insulation. Where the vacuum reduces the thermal conductivity, by reducing the pressure. And conventional insulation reduces the heat transfer that occurs through radiation. To quite successfully reduce the evaporation of hydrogen, it is necessary to cool the walls of insulating materials. This helps us to reduce the temperature difference, which allows us to reduce the heat flow.

Hydrogen is also stored in a bound form (metal hydrides). Hydrides are metal atoms that occupy the main place in the lattice, as well as hydrogen atoms that are located in these lattices under the guise of defects. The storage of hydrogen in the hydride form avoids the use of huge containers or cylinders that are required for the storage of gas-like or liquid hydrogen. Storage in this form allows you to reduce the volume by 4 times compared to storage in containers. Hydrogen in this form is easier to move. Costs are reduced because no conversion or liquefaction of hydrogen is required [2].

To obtain hydrogen from metal hydrides, two methods are used: hydrolysis and dissociation. If you use the hydrolysis method, it allows you to get twice as much hydrogen, but this process is irreversible. And the method of dissociation of hydride, allows you to create batteries.

Storage of hydrogen in the hydride form has no strict conditions, except for the cost of a particular material.

Cryoadsorption storage of hydrogen is a technology that combines hydric technology and liquid hydrogen storage technology.

The storage of hydrogen takes place in cryogenically cooled containers containing the hydrogen-adsorbing material.

This approach gives an advantage over the storage of hydrogen in the form of hydrides due to the fact that the amount of hydrogen per unit mass of the adsorbent is greater than that of hydride storage.

At the same time, the cost of the adsorbent is lower than the cost of metal alloys for hydrogen hydride storage. The capacity of the adsorbent depends on the temperature: the lower the cryoadsorption temperature, the higher the capacity. This significantly reduces the overall cost of hydrogen storage, even with the high cost of hydrogen cooling. The operating temperatures of the cryoadsorption are higher than for liquid hydrogen storage systems (-253 °C versus -208 to -195 °C for cryoadsorption. Adsorption occurs at an excess pressure of about 4.2 Mpa, and desorption occurs at 0.2 MPa.

An example of such hydrogen storage is the use of activated carbon as an adsorbent. At a temperature of -195 °C, the storage capacity of the product is 68 g / kg of adsorbent, with a further decrease in temperature to -208 °C, the capacity increases to 82 g/kg. As we can see, such a system of hydrogen storage in terms of mass characteristics exceeds not only the storage of hydrogen under pressure, but also in hydrides. However, in terms of storage volume, this scheme is inferior to metal-hydride and liquid-hydrogen storage methods [3].

To sum up, it can be said that storing hydrogen under pressure and in liquid form is the most cost-effective and proven over time. The remaining methods require further development.

**References:**


1. *Sistemy hraneniya vodoroda* [Hydrogen storage systems]. URL: https://cyberleninka.ru/article/n/sistemy-hraneniya-vodoroda/viewer (date accessed: 21.04.2021).
2. *Vodorodnaya energetika. Hranenie vodoroda* [Hydrogen energy. Hydrogen storage]. URL: http://www.abitura.com/modern_physics/hydro_energy/hydro_energy4.html (date accessed: 25.04.2021).
3. *Tehnologii i sposoby hraneniya vodoroda* [Storage technologies and methods]. URL: https://metallurgist.pro/tehnologii-i-sposoby-hraneniya-vodoroda/ (date accessed: 25.04.2021).


**Список литературы:**


1. *Системы хранения водорода*. URL: https://cyberleninka.ru/article/n/sistemy-hraneniya-vodoroda/viewer (дата обращения: 21.04.2021).
2. *Водородная энергетика. Хранение водорода* URL: http://www.abitura.com/modern_physics/hydro_energy/hydro_energy4.html/ (дата обращения: 25.04.2021).
3. *Технологии и способы хранения водорода*. URL: https://metallurgist.pro/tehnologii-i-sposoby-hraneniya-vodoroda/) (дата обращения: 25.04.2021).

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# LITHIUM-ION BATTERIES: THE CHEMISTRY OF PROCESSES AND THE MECHANISM OF OPERATION

**Abstract.** This article deals with lithium-ion batteries. The chemistry of processes occurring in them, the mechanism of operation and the history of development are described in an accessible and understandable way.

**Keywords:** lithium-ion batteries, lithium, accumulator, battery.

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# ЛИТИЙ-ИОННЫЕ АККУМУЛЯТОРЫ: ХИМИЗМ ПРОТЕКАЮЩИХ ПРОЦЕССОВ И МЕХАНИЗМ РАБОТЫ

**Аннотация.** В данной статье речь идёт о литий-ионных аккумуляторах. Доступно и понятно описан химизм процессов, протекающих в них, механизм работы и история развития.

**Ключевые слова**: литий-ионные аккумуляторы, литий, аккумулятор, батарея.

In the modern world, accumulators and batteries have become a part of our daily life. Before going to bed, a huge number of electrical appliances are put on “charging”: a cell phone, an electronic watch, a laptop, a portable battery, and others. The quantity of these devices depends only on person’s budget and love for modern technology. Usually, when buying the same gadgets that were discussed above, people do not think about what kind of battery they have. And only after months of use, the realization comes that it was necessary to find out this issue. A lot of studies have shown that a lithium-ion battery is the best for today. Consider the definitions that are important – the chemistry of processes occurring in lithium-ion battery and the mechanism of its operation [1; 6].

The history of the development of chemical current sources, electrochemical cells and accumulators goes back many years. After the invention of the electrophoretic machine, the first current source was the Volt element, named after its creator. Italian

physicist A. Volta explained the reason for the galvanic effect, discovered by his compatriot L. Galvani. In March 1800, he reported on the creation of a device, later called the "voltaic column". Thus, the era of electricity began, which gave light, heat, and the danger of electric shock to the world. These were galvanic (primary) elements that allowed us to begin the study of electricity. In the first half of the nineteenth century, they were the only sources of electrical energy. Before their appearance, only the laws of electrostatics were known, there was no concept of electric current and its manifestations. Already in May 1800, A. Carlyle and W. Nicholson carried out the electrolysis of water. In 1803, the processes of electrodeposition of metals were discovered. In 1807, electrolysis of molten salts was performed. Further chronology of discoveries:1819 – the magnetic action of the current by X. Oersted; 1820 – the interaction of conductors with the current by A. Ampere; 1827 – Ohm's law by G. Om; 1831 – the law of electromagnetic induction by M. Faraday; 1834 – the creation of the first electric motor by B. Jacobi; 1839 – the creation of the first fuel cell by U. Grove; 1843 – the thermal action of the current is described by J. Joule; 1859 – the first working acid-lead battery by G. Plante; 1860 – the first efficient generator by F. Hefner-Alteneck [2; 39].

After the creation of a fundamentally new source of electrical energy, an electromagnetic generator, chemical current sources have lost their primary importance. Generators surpassed their predecessors in economic and technical parameters, but chemical current sources (CCS) continued to be improved and developed as autonomous sources for communications. Chemical current sources are devices in which the energy of a chemical reaction is transformed into electrical energy. A new impetus to the improvement of CCS in the early twentieth century was the development of radio engineering and the automotive industry. Primary cells and batteries were the only power sources for communications, and starter batteries were required for cars. The development of military equipment also contributed to a sharp improvement in the characteristics of the CCS [2; 42]. So, the development of CCS gradually began, which has now led to a huge variety of accumulators and batteries. Now, having learned a brief history of the development of CCS, we will proceed to a detailed review of the mechanism of battery operation.

To explain the principle of battery operation, let's take a device that almost every inhabitant of the planet has in the modern world – a smartphone.

All batteries have positively and negatively charged contacts, through which electricity enters our smartphones. Electricity can be considered the flow of electrons (elementary particles with a negative electric charge, which are part of all atoms, and therefore of any ordinary substance). And in a smartphone, negatively charged electrons, flying from the negative pole to the positive, make devices such as speakers or display work. Since it is a lithium-ion battery, the electrons come from the lithium cell. At the negative pole, which is called the anode, lithium is stored between layers of carbon graphite (such as in your pencil). Graphite has a layered crystal structure, which allows lithium to be located in each of the layers. The technical name is intercalation. Graphite functions as a kind of stable place to store lithium atoms. One important property of the lithium element is that it "doesn't like" its external electron, and it wants to "get rid" of it. When there is a path from the negative contact to the

positive one, the electron breaks away from the lithium and goes there. At the same time, lithium "leaves" graphite and becomes positively charged (+1), that is, it becomes an ion. (An ion is an atom that has lost or gained an electron and thus gained a charge). When many lithium atoms receive a positive charge, a stream of electrons is created at this point. Now let's move on to the positive pole, which is called the cathode.

Here is cobalt (a silvery-white, slightly yellowish metal with a pinkish or bluish tint), which "gave" some of its electrons to oxygen, thus becoming positive, charged (+4). As a result, it "wants" to get the electrons back.

When positively and negatively charged electrical terminals are connected to the phone, the electrons "run" from lithium, which "has the desire to give away" the electron, through the chips and components of the phone, making them work up to cobalt, which "has the desire to accept" the electrons. With the flow of electrons from the negative to the positive pole, the cobalt side becomes more negatively charged, and the lithium side becomes more positive. The electrons "want to flow" in this direction, but at the same time the electrons "don't like to flow" into a region that is becoming increasingly negatively charged, this is because opposite charges attract and similar charges repel. So, to fix this, we give positively charged lithium ions that have recently "left" graphite a "path to go to the other side". This pathway is called the electrolyte. And its function allows you to "move" a positively charged lithium-ion from one side to the other, while not allowing an electron to pass through it. When lithium moves to the cobalt side, it again wedges or intercalates the cobalt and oxygen to turn into lithium cobalt oxide.

An accumulator is a result of this process. During the day, the lithium atoms leave the graphite layers and separate from their electrons to become lithium ions. Electrons "travel" from the negative pole through circuits and components (giving the energy to work with) to the positive pole (cobalt atoms). At the same time, lithium ions "travel" through the electrolyte to neutralize the accumulating charge and maintain the reaction. Thus, almost all of the lithium left the graphite layers and joined the cobalt to become lithium cobalt oxide. The accumulator went dead.

Now that the accumulator is low, let's charge it. When a smartphone is connected, the charger causes the electrons to move in the opposite direction. The electrons are "pulled" out of the cobalt, thus returning the cobalt to its positive state (+4) and "knocking out" the lithium ions. On the other hand, the electrons are returned to lithium, which is returned through the electrolyte to graphite. That is, it is the exact opposite of the previous process. Therefore, this accumulator is rechargeable. Lithium and its electrons move in one direction when a smartphone is used and in the other when it is charged [3].

Let's go back to the beginning and add a few important details. Firstly, the cathode and the anode must not be touched. If the cathode and anode came into contact and lithium remained in the graphite, the chemical reaction would continue unchecked and cause a fire or a small explosion. Therefore, an impermeable semi-conductive separator that allows lithium ions to pass through is located in the middle. Secondly, it is worth noting that graphite and cobalt peroxide does not know how to collect or distribute electrons, so a conductive layer of copper is added next to the graphite at the anode and a conductive layer of aluminum next to the cobalt peroxide. These two layers

or sheets are called collectors. Thirdly, there is always a certain percentage of lithium remaining in the anode, cathode, and electrolyte, regardless of whether the battery is fully charged or discharged. Fourthly, to maximize the battery capacity and allow it to fit into a smartphone, all these layers are squeezed and folded into a rectangular prism. Fifthly, to regulate the flow of electricity, an electrical chip is added to the top of the battery, which prevents overcharging and damage to the battery. This is probably the easiest way to explain the design of a lithium-ion battery [4; 45].

Summing up, the positive aspects of lithium-ion batteries can be highlighted. The specific characteristics of lithium-ion batteries are at least twice as high as those of nickel-cadmium batteries and perform well when operating at high currents, which is necessary, for example, when using these batteries in cell phones and laptop computers. Lithium-ion batteries have a fairly low self-discharge (2-5 % per month). Manufacturers are continuously improving the technology of lithium-ion batteries. There is a constant search and improvement of the electrode materials and the composition of the electrolyte. In parallel, efforts are being made to improve lithium-ion batteries' safety at the level of individual current sources and the level of control electrical circuits [5; 5].

**References:**


1. Kedrinskij, I. A., Dmitrienko, V. E., Grudyanov, I. I. *Litievye istochniki toka*. [Lithium current sources]. Moscow: Energoizdat, 2012. 240 p. (in Russian).
2. Lavrus, V. S. *Istochniki energii* [Energy sources]. Kiev: NiT, 1997, pp. 39-42 (in Russian).
3. Tablante, Teddy (2019) How do Lithium-ion Batteries Work? Branch Education. URL: https://branch.education/#/new-page-1/ (date accessed: 05.03.2021).
4. L'vov, A. L. *Litievye himicheskie istochniki toka* [Lithium Chemical Current Sources]. *Tsorosovskij obrazovatel'nyj zhurnal* [Soros Educational Magazine]. 2011. Vol. 7. № 2, pp. 45-51 (in Russian).
5. Skundin, A. M. *Litij-ionnye akkumulyatory: sovremennoe sostoyanie, problemy i perspektivy.* [Lithium-ion batteries: current state, problems and prospects.]. *Elektrohimicheskaya energetika.* [Electrochemical power engineering]. 2011. Vol. 1, pp. 5-15 (in Russian).


**Список литературы:**


1. Кедринский И. А., Дмитриенко В. Е., Грудянов И. И. Литиевые источники тока. – М.: Энергоиздат, 2012. – 240 с.
2. Лаврус В. С. Источники энергии. – Киев: НиТ, 1997. – С. 39-42.
3. *Tablante Teddy*. How do Lithium-ion Batteries Work? // Branch Education. 2019. URL: https://branch.education/#/new-page-1/ (дата обращения: 05.03.2021).
4. Львов А. Л. Литиевые химические источники тока // Соросовский образовательный журнал. – 2011. – Т. 7. – №3. – С. 45-51.
5. Скундин А. М. Литий-ионные аккумуляторы: современное состояние, проблемы и перспективы // Электрохимическая энергетика. – 2011 – Т. 1. – С. 5-15.

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## BIODEGRADABLE POLYMER-BASED MATERIALS

**Abstract**. This article is devoted to the study of polyampholic hydrogels, namely their synthesis, properties and application. Various factors affecting the synthesis of polyampholic hydrogels and as a consequence their properties are also considered.

**Keywords**: biodegradable polymers, biodegradable composites, polyvinyl alcohol, starch.

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## БИОРАЗЛАГАЕМЫЕ МАТЕРИАЛЫ НА ОСНОВЕ ПОЛИМЕРОВ

**Аннотация**. Данная статья посвящена изучению полиамфолитных гидрогелей, а именно их синтеза, свойств и применению. Также рассмотрены различные факторы, влияющие на синтез полиамфолитных гидрогелей и, как следствие, на их свойства.

**Ключевые слова**: биодеградируемые полимеры, биоразлагаемые композиционные материалы, поливиниловый спирт, крахмал.

Today it is difficult to imagine any sphere of human activity where polymeric materials are not used. The main problem of synthetic polymersusage is their chemical stability allowing towithstand natural physical and chemical factors for a long time, such as: solar radiation, heat, humidity, air oxygen and biological factors, for example impactof microorganisms during many decades without considerable destruction of materials. Polymers and their residues are preserved in the environment for a long time, causing significant ecological harm to the environment, and the combustion of such materials leads to the emission of toxic gases. For this reason in recent years the world has shown a particular interest in biodegradable and biocompostable polymers [1]. Natural high molecular weight compounds (proteins, nucleic acids, polysaccharides, glycoproteins, lipoproteins, liposaccharides, etc.) decompose relatively quickly

(several months to several years) into simple chemical compounds. These compounds do not have such a strong detrimental effect on modern ecology.

However, biopolymer materials do not have such a wide range of properties as synthetic polymer products, so they cannot fully replace artificial thermoplastic materials. It is also worth noting that at the moment biodegradable materials are not widely used in domestic sphere for the reason that their decomposition time in the environment can be the same as that of plastics.

Biodegradable polymers are a class of high molecular weight compounds containing products of biological organisms (cellulose, protein, starch, nucleic acid, natural resin, etc.) capable of decomposing into environmentally neutral substances under appropriate conditions [2].

Biodegradable polymers undergo significant changes in their molecular weight and mechanical properties when exposed to a biologically active medium or provide nutrients that ensure the growth of microorganisms. Hydrolysis and photochemical degradation of biodegradable polymers take place in such media. Eventually biopolymers decompose into components that participate in the natural cycle, such as water, carbon dioxide, biomass and others. The main advantage of biopolymers is their ability to biodegrade within a very short time, unlike traditional analogues derived from petrochemical raw materials.

One of the most promising biodegradable materials are aliphatic polyether based on lactic acid – polylactides (PLA) obtained by polycondensation of lactic acid or polymerization of lactide. Corn, sugar cane, rice etc. are used as raw materials for PLA production. PLA products are characterized by high rigidity, transparency and luster.

It is also worth noting that one of the most important biopolymers in industry is starch-based biopolymer. One of the first materials based on starch from various types of plant raw materials – potatoes, corn, wheat, rice-were obtained. A large review on biodegradable materials based on starch and its derivatives is presented by Russian scientists.

Starch is a polysaccharide accumulated during the vital activity of plants in their tubers, seeds, stems and leaves. The main sources for its industrial production are potatoes, rice, wheat, and corn. In plants, starch is present in the form of granules, which vary in diameter from 5 to 100 microns.

Starch is not a true thermoplastic, but in the presence of a plasticizer (water, glycerin, sorbitol, etc.) at high temperatures of 90-180 °C and shear it melts and liquefies, thus allowing it to be used in molding, extrusion and blow molding equipment used for synthetic plastics.

PVS is a linear, weakly branched polymer, so one of the most promising ways to reduce the solubility is the use of low molecular weight substances that interact with PVS macromolecules and form transverse chemical bonds, which, on the one hand, form a spatial network structure and, on the other hand, increase the degree of polymerization of PVS.

**Problems of biodegradability**

At the moment, science does not yet have precise criteria for assessing biodegradability and compostability. Composting is a self-heating, aerobic process of biodegradation of organic waste with plant dry additives. Under optimal conditions:

temperature, humidity and pH, composting is completed in 3 months; under normal conditions, it takes 1-2 years to produce humus for soil fertilization. The composting process is mainly an oxidative one. It can proceed in piles or cauldrons from 94 to 157 cm in height at a certain moisture content.

Biodegradation of mixtures depends on the size of crystallites, the presence of amorphous part, the physical state of the surface, the combination of phases, the species of microorganisms in the biodegradable medium and is determined mainly by three parameters: absorption of oxygen, change in optical density, loss of weight of the tested product and change in weight of the resulting biomass.

It is better if both hydrolytic and enzymatic degradation occur simultaneously in the biodegradation process. And while there is debate about the applicability of certain standardisation methods for biodegradation and composting, all over the world refer to the requirements of DIN 54900, which is divided into 3 parts: DIN 54900-1, which determines the presence of harmful (organic and inorganic) products that cannot be degraded in compost; and DIN 54900-2, which determines the complete biodegradation of each component in the laboratory and others [3].

The international institutions that issue a specific certificate on the biodegradability of plastic products are the following: 1) The American Society ForTesting Materials (ASTM) in the United States, 2) Japan's GREENPLA program, 3) the European DIN certification, and 4) the European Committee for Standardization (CEN).

Also one of the important problems is the area required to grow the necessary materials for biodegradable polymers, because of limited resources.

**Getting**

Starch is a polysaccharide that accumulates in the tubers, seeds, stems and leaves of plants. In plants, starch is present in the form of granules, which vary in diameter from 5 to 100 microns depending on the plant species. This starch is called natural or native starch. Corn starch (CK) represents a powder of white color with grain size of 10-15 microns. Modified starch is supplied in the form of porous agglomerated granules with the size up to 1 mm. Starch has amorphous-crystalline structure and is not glycols, sorbitol, etc.), at high temperature (90-180 °C) and shear it melts and liquefies, forming so-called thermoplastic starch (TPC), which allows it to be used in molding, extrusion and blow molding equipment used for synthetic plastics. Unfortunately, TPC has several disadvantages, such as a strong hydrophilic character (sensitivity to water) and rather poor mechanical properties compared to conventional polymers.

Carboxymethyl starch (CMC) is produced by treating potato starch with monochloroacetic acid in an alcoholic medium, followed by neutralization of the mixture and soaking of the product with 8 % alcohol. The degree of substitution of hydroxyl groups in the starch molecule by carboxymethyl groups is 0.1. Since the structural changes are insignificant, the properties of this starch are similar to those of natural starch [4]. However, due to partial destruction of hydrogen bonds some weakening of the structure of the starch grain occurs. Thereforestarch dissolves readily in cold water, its solutions are more resistant to mechanical and thermal influences, are not prone to retrogradation and syneresis that distinguishes it from natural starches [5].

To prepare the initial mixture of PVA with starches in this work we used “cold” mixing of the components in a high-speed blender. ε-caprolactam (ε-CL) solution was used to modify PVA, and propylene glycol (PG) and glycerol (GL) were used to plasticize PVA and starches. Native corn starch (10 wt %) and other fillers (microvolastonite – MW) and wood flour (WF) – 10 wt % each) were introduced at the last stage of mixing.

**References:**


1. Valeeva, N. Sh., Hasanova, G. B. *Biopolimery – perspektivnyj vector razvitiya polimernoj promyshlennosti* [Biopolymers – a promising vector for the development of the polymer industry]. Vestnik Kazanskogo tekhnologicheskogo universiteta [Bulletin of the Kazan Technological University]. 2013.
2. Vil’danov, F. SH., Latypova, F. N., Krasuckij, P. A. *Biorazlagaemye polimery – sovremennoe sostoyanie i perspektivy ispol’zovaniya* [Biodegradable polymers – current state and prospects of use. Bashkirskij himicheskij zhurnal [Bashkir Chemical Journal]. 2012.
3. Physical properties of starch-based foams as affected by extrusion temperature and moisture content // J. Y. Cha [et al.] // Ind. Crops Prod. 2001.
4. Pavlenok, A. V., Davydova, O. V., Drobyshevskaya N. E., Poddenezhnyj, E. N., Bojko, A. A. [Preparation and properties of biodegradable composite materials based on polyvinyl alcohol and starch]. *Vestnik Gomel’skogo gosudarstvennogo tekhnicheskogo universiteta* named after P.O. Suhogo [Bulletin of the Gomel State Technical University named after P. O. Sukhoi]. 2018.


**Список литературы:**


1. Валеева Н. Ш., Хасанова Г. Б. Биополимеры – перспективный вектор развития полимерной промышленности // Вестник Казанского технологического университета. – 2013.
2. Вильданов Ф. Ш., Латыпова Ф. Н., Красуцкий П. А. Биоразлагаемые полимеры – современное состояние и перспективы использования // Башкирский химический журнал. – 2012.
3. Physical properties of starch-based foams as affected by extrusion temperature and moisture content // J. Y. Cha [et al.] // Ind. Crops Prod. – 2001.
4. Павленок А. В., Давыдова О. В., Дробышевская Н. Е., Подденежный Е. Н., Бойко А. А. Получение и свойства биоразлагаемых композиционных материалов на основе поливинилового спирта и крахмала // Вестник Гомельского государственного технического университета им. П. О. Сухого. – 2018.

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## METHODS OF DETERMINATION OF THE OXYGEN MODE OF LAKE LADOGA

**Abstract.** The article presents methods of oxygen mode determination in water bodies – the level of dissolved oxygen, temperature, $BOD_5$, pH, specific electrical conductivity, water saturation with dissolved oxygen. Two methods for determining the concentration of dissolved oxygen in water are compared. The measurements results are presented for the oxygen level, temperature, specific electrical conductivity – portable device oximeter Hach HQ30d and the method of laboratory analysis of Winkler, pH – laboratory ionomer I-160.

**Keywords:** oxygen mode, dissolved oxygen, Winkler method, instrumental method, water body.

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## МЕТОДЫ ОПРЕДЕЛЕНИЯ КИСЛОРОДНОГО РЕЖИМА ЛАДОЖСКОГО ОЗЕРА

**Аннотация.** В статье представлены методы определения параметров кислородного режима в водном объекте – уровень растворенного кислорода, температура, $БПК_5$, pH, УЭП, насыщенность воды растворенным кислородом. Сравниваются два метода определения концентрации растворенного кислорода в воде. Приводятся результаты измерений уровня кислорода, температуры, УЭП – портативным прибором оксиметр Hach HQ30d и методом лабораторного анализа Винклера, pH – лабораторным иономером И-160.

**Ключевые слова:** кислородный режим, растворенный кислород, лабораторный метод Винклера, инструментальный метод, водный объект.

One of the most important parameters that determine the water quality in the lake is the level of dissolved oxygen. The oxygen mode of the reservoir depends on the biogenic load and mixing conditions. A decrease in the dissolved oxygen content contributes to the appearance of anaerobic conditions in the reservoir bottom, and sometimes in a significant thickness of the water mass, which contributes to the course of chemical and biochemical reactions of the reducing type. The forecast of possible changes in the oxygen mode is important for determining the quality of water resources and their use, both in the near and distant future, in the conditions of changing climatic and anthropogenic impacts.

The purpose of this study is to determine the parameters of the oxygen mode of the lake when comparing methods for determining oxygen in the water.

The content of dissolved oxygen (DO) in water characterizes the oxygen mode of the reservoir and is of crucial importance for assessing its ecological and sanitary condition. Oxygen must be contained in the water in sufficient quantities, providing conditions for the respiration of hydrobionts. It is also necessary for the self-purification of water bodies, as it participates in the processes of oxidation of organic and other impurities, respiration of hydrobionts, and decomposition of bottom sediments. The decrease in the concentration of DO indicates a change in the biological processes in the reservoir, the pollution of the water body with biochemically intensively oxidizing substances, primarily organic ones. The importance of determining the parameter of biochemical oxygen consumption (BOD), which changes its value depending on the level of oxygen in the water, is justified.

A decrease in the concentration of DO to 2 mg O/l causes mass death of fish and other hydrobionts. There are in the reservoirs concentration of DO should be at least 4 mg O/l in any period of the year before the afternoon. The threshold limit value (TLV) of oxygen dissolved in water for fisheries reservoirs is set at 6 mg O/l – for valuable fish species, or 4 mg O/l – for other breeds. TLV for the $BOD_5$ parameter is equal to 2 mg O/l.

Determination of the DO in water is carried out by the iodometric titration method, the Winkler method, is widely used and generally accepted in sanitary-chemical and environmental control. The method for determining the concentration of DO is based on the ability of manganese (II) hydroxide to oxidize in an alkaline medium to manganese (IV) hydroxide, while quantitatively binding oxygen. In an acidic environment, the manganese (IV) hydroxide reverts to the divalent state, while oxidizing the equivalent amount of iodine bound to oxygen. The released iodine is titrated with a solution of sodium thiosulfate in the presence of starch as an indicator. The amount of sodium thiosulfate solution consumed for titration is proportional to the concentration of dissolved oxygen. The $BOD_5$ parameter was determined using the method based on the dissolved oxygen content after 5 days of incubation without access to air and light [1].

Another method for determining DO is using the Hach HQ30d oximeter and LDO sensor for measuring oxygen concentration by the luminescent method. The Lange LDO sensor includes two main components: a sensor covered with a phosphor layer applied to a transparent substrate, and a sensor housing with blue and red LEDs (light-emitting diodes), a photodiode, and an electronic signal converter. In the

operating position, the cover is screwed onto the sensor and submerged in water. The oxygen molecules in the analyzed sample come into direct contact with the phosphor. The luminescence decay time is analyzed to determine the oxygen concentration.

The Hach HQ30d oximeter and a special sensor were used to determine the specific electrical conductivity (SEC) and temperature in addition to dissolved oxygen.

The research was conducted in the northeastern part of Lake Ladoga in March 2021. Water samples were taken from the surface of the water. Such parameters as the dissolved oxygen level by the device and laboratory analysis, temperature, $BOD_5$, pH, SEC, water saturation with dissolved oxygen, the dissolved oxygen measurements, taking into account errors, are determined. The results are presented in Table 1.

Table 1

Oxygen mode parameters of the northeastern part of Lake Ladoga March 2021

| Sample | Water temperature, Hach HQ30d Oximeter | DO, Hach HQ30d Oximeter | DO, the Winkler method | Saturation $O_2$ level, Hach HQ30d Oximeter | pH, ionomer I-160 | SEC, Hach HQ30d Oximeter | $BOD_5$, the Winkler method |
|---|---|---|---|---|---|---|---|
| **Units** | **T°C** | **mg O / l** | **mg O / l** | **%** | **pH units** | **mS/cm** | **mg O / l** |
| 1 | 0,6 ± 0,3 | 11,89 ± 0,5 | 12,97 ± 0,1 | 92 ± 0,1 | 7,17±0,25 | 94±0,5 | 0,9 ± 0,3 |
| 2 | 0,5± 0,3 | 12,61 ± 0,5 | 12,33 ± 0,1 | 88± 0,1 | 7,16±0,25 | 93±0,5 | 1,2 ± 0,3 |
| 3 | 0,5± 0,3 | 12,51 ± 0,5 | 12,33 ± 0,1 | 88± 0,1 | 7,37±0,25 | 95±0,5 | 1,2 ± 0,3 |
| 4 | 0,6± 0,3 | 11,82 ± 0,5 | 13,10 ± 0,1 | 98± 0,1 | 7,30±0,25 | 95±0,5 | 0,8 ± 0,3 |
| 5 | 0,5± 0,3 | 11,95 ± 0,5 | 12,93 ± 0,1 | 93± 0,1 | 7,20±0,25 | 95±0,5 | 0,9 ± 0,3 |
| 6 | 0,6± 0,3 | 14,01 ± 0,5 | 13,36 ± 0,1 | 99 ± 0,1 | 7,20±0,25 | 98±0,5 | 0,8 ± 0,3 |

During the scientific study, the main parameters of the oxygen mode were determined – the level of dissolved oxygen, temperature, $BOD_5$, pH, SEC, water saturation with dissolved oxygen. The pH and $BOD_5$ values are within the TLV. The SEC values are in the range of 93-98 mS/cm. In spring, the dissolved oxygen content in the surface waters of Lake Ladoga in the northeastern part ranges from 11 to 14 mg O / l [2]. It is noted that when determining the oxygen content by the Winkler method, the measurement error is less than when determining the instrumental method using the oximeter device. It is also important to note that the maximum permissible concentration of dissolved oxygen meets all standards. There is no oxygen deficiency in the surface of the northeastern part of Lake Ladoga [3].

**References:**

1. Federal environmental regulation 14.1:2:3:4.123-97 Quantitative chemical analysis of water. The method of measuring the biochemical oxygen consumption after n-days of incubation (BODtot) in surface fresh, underground (ground), drinking, wastewater and treated wastewater. (in Russian)
2. Granberg, K. (1996) The impact of effluents of Pitkäranta pulp mill on the water quality of Lake Ladoga: a model study. Hydrobiologia. 322(1), pp. 159-166.
3. Samer, M. Biological and chemical wastewater treatment processes // Wastewater Treatment Engineering. 2015, pp.1-50.

**Список литературы:**

1. ПНД Ф 14.1:2:3:4.123-97. Количественный химический анализ вод. Методика выполнения измерений биохимического потребления кислорода после n-дней инкубации ($БПК_{полн}$) в поверхностных пресных, подземных (грунтовых), питьевых, сточных и очищенных сточных водах. – М.: Стандартинформ, 2004. – 30 с.
2. Granberg K. The impact of effluents of Pitkäranta pulp mill on the water quality of Lake Ladoga: a model study // Hydrobiologia. 322(1). – 1996. – С. 159-166.
3. Samer M. Biological and chemical wastewater treatment processes // Wastewater Treatment Engineering. – 2015. – С.1-50.

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## DESIGN OF AN AUTOMATED DATABASE MANAGEMENT SYSTEM OF “DEPARTMENT”

**Abstract.** The article discusses the process of creating a database for the Department of Applied Mathematics and Informatics of the HSTE SPbGUPTD (hereinafter referred to as AM&I) for solving such problems as: entering, storing and issuing data on the work of the unit, as well as creating a convenient working platform with documents necessary for the department.

**Key words:** database, management system, MS Access.

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# СОЗДАНИЕ АВТОМАТИЗИРОВАННОЙ СИСТЕМЫ УПРАВЛЕНИЯ БАЗЫ ДАННЫХ «КАФЕДРЫ»

**Аннотация.** В статье рассматривается процесс создания базы данных для кафедры прикладной математики и информатики ВШТЭ СПбГУПТД (далее ПМИ) для решения таких задач, как ввод, хранение и выдача данных о работе подразделения, а также создания удобной рабочей площадки с документами, необходимыми кафедре.

**Ключевые слова:** база данных, система управления, MS Access.

It is difficult to imagine the modern world of information technology without the use of any databases. Almost all systems to one degree or another are associated with the functions of storing information for a long time as well as processing this very information. In fact, information has become a kind of factor that determines the effectiveness of any area of activity.

The bases for work, storage and planning are all kinds of archives, logs, lists, etc. Their number is growing every minute and this is not very convenient since a large amount of data must be stored somewhere. Due to a large amount of various information the searching necessary information or making changes to it manually is a very hard and long process. Therefore, it has been essential to create various databases. Microsoft Access is currently one of the most popular desktop (personal) software database management systems [1; 5-21], [2; 10-13].

Just after starting MS Access you need to open the “New” section on the “File” tab. In this tab you can create a new database or open an existing one.

After successful creation of the database an empty table will appear on the screen. To form its structure, click on the “Table 1” tab and select “Constructor”. We save it under the name “Teachers” this will start our database. Next, in this constructor, we will create 10 rows of our future table. Then, for each field of the table, it is necessary to select a data type from the presented list (Fig. 1).

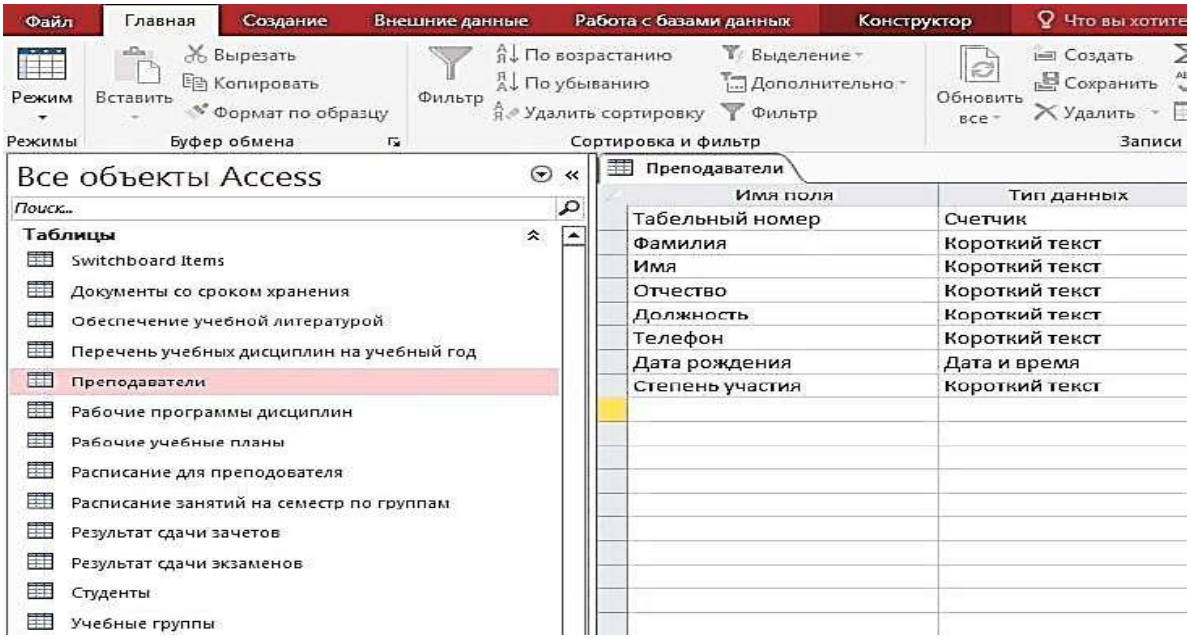


Fig. 1. Teachers table data types

Now create the rest of tables using the same principle. It becomes difficult to fill the database because of a huge number of fields in the table. You may skip a value, enter an incorrect one or of a different type. In this situation forms are rescued automatically, so you can quickly fill out entities, and an error is minimized.

Database will contain many forms, as well as a form for the “Teachers” table (Fig. 2).

For more convenient navigation through the form, three buttons: “Previous record”, “Next record” and “Add record”.

When you create a data schema in Access, it defines and remembers the relationships between tables. To establish connections we use the key fields:

“Group Number” and “Group”. For example, between the primary key (Group Number) from the study groups table and the secondary key (Group) from the Students table we establish a one-to-many relationship.

“Add table” in the background of the inactive window “Data schema”. In the window. “Adding tables”, select the table names and press the button

“Add”, in this case all selected tables will appear in the “Data Scheme” window. After that, you need to close the dialog box.

Next, you need to establish relationships between the tables. For example, let’s establish a relationship between the tables “Study groups” and “Students”.

As a result, the “Edit Links” window appeared. A one-to-many relationship between tables appears in the Data Schema window.

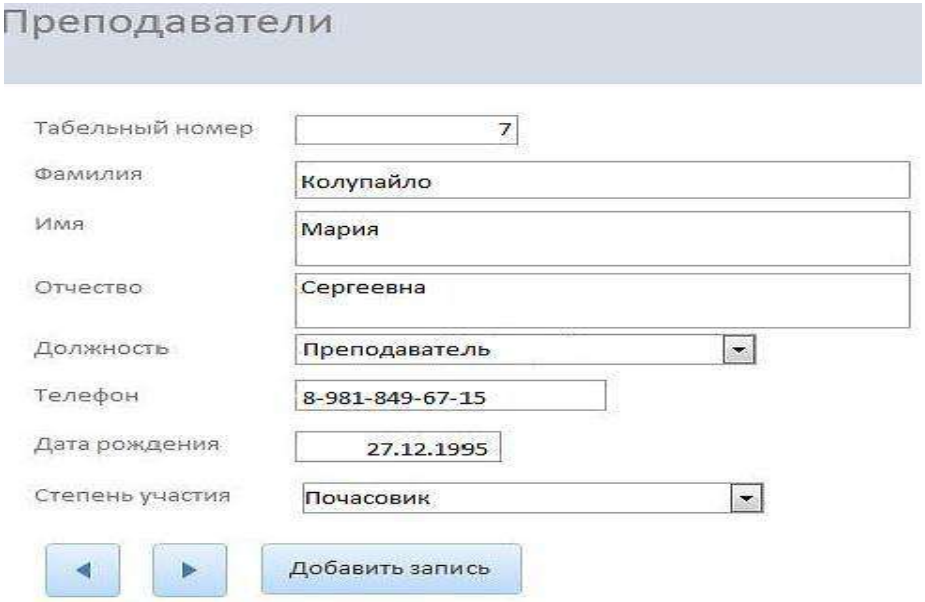


Fig. 2. The final view of the “teachers” form

Group number and Students for the Group and Group number fields. In the same way, we will create links for all other tables presented in the database.

Queries are used so that, if necessary, it would be possible to quickly obtain the necessary information from the database. They can also be used if you need to update or delete a certain number of records.

Macro was being created, now when it is executed, the “Students” form will open.

Reports are used to display any information that the database contains. They provide the information you need in an easy-to-read format.

And the last one – create the main button form. The main button form is created for navigating the database. This form can be used as the main database menu. The main button form elements are form and report objects.

This was done for the remaining pages. Now, when choosing our MBF, buttons for switching to other pages appeared on the title page.

As a result of the actions taken, the “Department” database includes the following objects: data schema; tables; forms; requests; reports; macros; MBF (Fig. 3).


Fig. 3 The final view of the main button form

At the moment it is difficult to imagine any enterprise, production, institution without a database. They all have a huge amount of data that needs to be stored somewhere. Database management systems (DBMS) do an excellent job with this. To solve the set tasks, in the MS Access environment were created: 12 tables, all of them were interconnected, added queries, reports and macros. The result of the work was the created main button form for easy data entry and modification, as well as quick navigation between tables.

The capabilities of the created database: data entry; data storage; providing quick access to all data; data addition and updating; creation of controls to improve the interface; data output for printing in the form of reports. At the moment, databases are used in the widest range of human activities. Without them, it is impossible to imagine the work of shops, schools, medical institutions, banks, etc.

**References:**

1. Bekarevich, Y., Pushkina, N. (2013) Microsoft Access for 21 lessons. Moscow: BHV. 534 p. (in Russian).
2. Kiselev, S. V. (2008) Office applications MS Office: textbook. allowance. Moscow: M.: Academy. 80 p. (in Russian).

**Список литературы:**

1. Бекаревич Ю., Пушкина Н. Microsoft Access за 21 занятие. – Москва: БХВ, 2013. – 544 с.
2. Киселев С. В. Офисные приложения MS Office: учеб. пособие. – Москва. М.: Академия, 2008. – 80 с.

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## WE ARE NOT ALONE…OR ARE WE?

**Abstract.** The author presents scientific theories and opinions in the field of terrestrial intelligence. Among the most famous of them are Fermi Paradox and Zoo Hypothesis.

**Key words:** extraterrestrial intelligence, UFO, aliens, hypothesis.

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## МЫ НЕ ОДИНОКИ…ИЛИ КАК?

**Аннотация.** В работе изложены научные теории и гипотезы в области поиска внеземного разума, самыми известными из которых являются Парадокс Ферми и Гипотеза зоопарка.

**Ключевые слова:** внеземной разум, НЛО, пришельцы, гипотеза.

The relevance of our paper is the problem of searching for extraterrestrial intelligence which has always been one of the key problems of science and has not been solved yet. The author is making an attempt to analyze the investigated information in order to make a conclusion about current state of researching.

“In the known part of the Universe we can count millions of billions of suns. It means we’ve got the same number of planets similar to Earth. It is unimaginable to denylifeexistence on them. If it has emerged on Earth, then why can’t it appear in the same circumstances on the Earth-like planets? There can be less of those planets than suns but still they have to exist. We can deny life on 50, 70, 90 percent of these planets but that is absolutely impossible.

What is the denial of other intelligent civilizations existence based on?

We are told: if they existed, they would visit Earth. My answer is: they probably will, but time hasn’t come for that. Time has to come for humanity to reach the level of development that is enough for us to be visited by extraterrestrial civilizations. We

won't ever visit wolves, venomous snakes or gorillas to say hello. We only kill them. And the pure inhabitants of heavens don't want to do the same to us" [1].

Are we alone out there?

Scientists have been arguing for years: some can't prove anyone actually exists, but others can't prove they are wrong.

Well, right before I start let's get a few things straight. Astrology is not equal to astronomy, area 51 is a 100 % fake and the American government isn't hiding any alien bodies under the pentagon building.

We need to look at pure facts we've got: we haven't ever seen any UFOs, it simply hasn't been captured, and no signal from space has ever been found.

But the Universe is so huge! Why can't we make a contact with aliens?

That's what ***Fermi Paradox*** is about. The Fermi Paradox is named after Italian-American scientist Enrico Fermi and is a contradiction between the lack of evidence for extraterrestrial civilizations and various high estimates for their probability [2].

There are billions of stars in the Milky Way Galaxy similar to the Sun, so it means that there's a really high probability of Earth-like planets' existence. Most of stars and hence the planets are much older than the Sun, then according to what we've got on Earth, intelligent life could develop a long time ago, and now these civilizations are on the next, higher level. Some of them may have developed interstellar travel which is the technology humanity is only investigating now.

And since there are so many Sun-like stars, then the Earth should have already been visited by extraterrestrial civilizations. However, there are no proofs this has happened.

The Fermi Paradox has been tried to be explained many times, primarily suggesting that intelligent extraterrestrial civilizations are extremely rare, that their lifetime is too short and that they definitely exist but we just see no evidence!

There are some assumptions existing as explanations to the Fermi Paradox which form the theoretical part of the researches in this area.

The first one, the most popular and, in my opinion, the best explaining how the life works is ***the Zoo Hypothesis.*** The hypothesis is that extraterrestrial life intentionally avoids communication with the Earth and one of the main interpretations is that it does so to allow for natural evolution as well as social and cultural development [3].

The variant of it was suggested in 1973 by the formerMIT Haystack Observatory scientist John A. Ball and is called the laboratory hypothesis, where the Earth is just a big laboratory and humanity is being subjected to experiments.

And the craziest alternative to the Zoo Hypothesis, ***the Simulation Hypothesis***, makes a proposition that we are living in a computer simulation being run by a post-human civilization.

Even a complete absence of anything that could have been a proof the ET civilizations exist, humanity, as we can see, will never stop researching.

For sure astronomy could not exist without mathematics. In 1961 Dr. Frank Drake wrote an equation, but not for purposes of quantifying the number of civilizations, butas a way to stimulate scientific dialogue at the first scientific meeting on the search for extraterrestrial intelligence. The equation summarizes the main

concepts which scientists must contemplate when considering the question of other radio-communicative life [4].

Obviouslyhumanity hasn't stopped on theory making, but has managed to come to the practice. Scientific investigation began in early 1900s, right after the advent of the radio.

We can call this a science revolution. Astronomy never got that far before, so the radio has started a completely new era; the start of SETI, aka Search for Extraterrestrial Intelligence (which is a collective term for scientific searches for intelligent ET life) was made.

However, science has been interested in researches within the Solar System even earlier. For example, Serbian-American inventor Nikola Tesla suggested that his wireless electrical transmission system could be used to contact beings on Mars.Unfortunately, after the experiment took place at his Colorado Springs experimental station in 1899 and some signals were detected, later analysis has led to a few explanations, including that Tesla has simply misunderstood his own new technology and could have picked up natural radio noises from Jupiter's moon, Io, moving through the magnetosphere of the planet or has been observing signals from Marconi's European radio experiments. In the early 1900s G. Marconi, by the way, started a belief that radio could be used to contact Martians. Lord Kelvin and David Peck Todd have shared this belief, too [5].

But the first modern SETI experiment was performed in 1960 by Frank Drake, who was already mentioned as the author of his self-titled equation. The experiment took place at Greek Bank, West Virginia and was an attempt to examine the stars Tau Ceti and Epsilon Eridani using a radio telescope 26 meters in diameter. Results were disappointing: Drake did not find anything of interest [6].

The most powerful signal (30 times more powerful than the average space radiation) ever captured was a Wow! Signal on August 15, 1977. It was a strong narrowband signal received by the Ohio State University's Big Ear radio telescope. The signal lasted for 72 seconds, but when an astronomer spotted it on a computer printout days later, he was so impressed that he quickly scrawled "Wow!" in red pen across the page. The data looked much like what SETI astronomers expected to see from an alien intelligence. However, despite many attempts to follow up on the find, the so-called "Wow! Signal" has never reappeared [7].

Nevertheless, researches haven't only been based on looking for signals, but also on sending them to space.

The Wow! Signal has been tried to be replied in 2012. Alien or not, National Geographic took everything seriously and literally included thousands of tweets tagged "#chasingUFOs" into the message they sent to space, which consisted of binary code encryptions and was transmitted to the same direction the original signal came from. If the Zoo Hypothesis is the truth, this might be one of the reasons aliens avoid us.

Humanity hasn't only sent tweets to space, though.

The first ever radio broadcast intended for ET civilizations is "Mir, Lenin, USSR" sent in 1960 to Venus. It reflected off the planet surface and was received back in 4 and a half minutes [8].

Less political message, the Arecibo message (sent in 1974) is an interstellar radio message carrying basic information about humanity and the Earth. The content of the message was designed by Frank Drake [5].

It consisted of seven parts

1. The numbers one (1) to ten (10) (white).
2. The atomic numbers of the elements hydrogen, carbon, nitrogen, oxygenand phosphorus, which make up deoxyribonucleic acid (DNA) (purple).
3. The formulas for the chemical compounds that make up the nucleotides of DNA (green).
4. The estimated number of DNA nucleotides in the human genome and a graphic of the double helix structure of DNA (white and blue, respectively).
5. The dimension (physical height) of an average man (blue/white), a graphic figure of a human being (red) and the human population of Earth (white).
6. A graphic of the Solar System, indicating which of the planets the message is coming from (yellow).
7. A graphic of the Arecibo radio telescope and the dimension (the physical diameter) of the transmitting antenna dish (purple, white and blue).

Along with serious scientific works, there are many of pseudo-scientific projects: Doritos Advert (2008), CNES Cosmic Connexion (2006), Craiglist Messages (2005) and others [3].

Some of the messages sent to Cosmos by people will get to their targets in more than 400 years, and the Arecibo message, as predicted, will reach the Hercules constellation approximately by the year 25974.

To sum up, we may see that despite lack of research results, the scientific work keeps being done and SETI remains to be funded and developed.

**References:**


1. Tsiolkovsky, K. (1933). Planets Are Settled by Living Beings. URL: https://ru.wikisource.org/wiki (date accessed – 02.05.2021).
2. Fermi Paradox. URL: https://en.wikipedia.org/wiki/Fermi_paradox (accessed – 01.05.2021).
3. Zoo Hypothesis. URL: https://en.wikipedia.org/wiki/Zoo_hypothesis (date accessed – 28.04.2021).
4. Drake Equation. URL: https://en.wikipedia.org/wiki/Drake_equation (date accessed – 03.05.2021).
5. List of Interstellar Radio Messages. URL: https://en.wikipedia.org/ wiki/List_of_interstellar_radio_messages (date accessed – 05.05.2021).
6. Early SETI: Project Ozma, Arecibo Message. URL: https://www.seti.org/seti-institute/project/details/early-seti-project-ozma-arecibo-message (date accessed – 02.05.2021).
7. The Wow! Signal: an Alien Missed Connection? URL: https://astronomy.com/news/2020/09/the-wow-signal-an-alien-missed-connection (date accessed – 03.05.2021).
8. Morse Message (1962). URL: https://en.wikipedia.org/wiki/Morse_Message_ (1962) (date accessed – 26.04.2021).

**Список литературы:**

1. Циолковский К. Планеты заселены живыми существами. URL: https://ru.wikisource.org/wiki (дата обращения– 02.05.2021).
2. Парадокс Ферми. URL: https://en.wikipedia.org/wiki/Парадокс_Ферми (дата обращения – 01.05.2021).
3. Гипотеза Зоопарка. URL: https://en.wikipedia.org/wiki/Zoo_hypothesis (дата обращения – 28.04.2021).
4. Уравнение Дрейка. URL: https://ru.wikipedia.org/wiki/ Uravnenie Dreika_(дата обращения– 03.05.2021).
5. Список межзвездных планетных сигналов. URL: https://en.wikipedia.org/ wiki/List_of_interstellar_radio_messages (дата обращения – 05.05.2021).
6. Ранний SETI: Проект Озма, Послание Аресибо. URL: https://www.seti.org/seti-institute/project/details/early-seti-project-ozma-arecibo-message(дата обращения – 02.05.2021).
7. Сигнал «Wow!»: пропущенный сигнал от инопланетян? [Signal Wow!: Propuschenny Signal ot Inoplanetyan?]. URL: https://astronomy.com/news/2020/09/ the-wow-signal-an-alien-missed-connection (дата обращения – 03.05.2021).
8. Послание Морзе. URL: https://en.wikipedia.org/wiki/Morse_Message_(1962) (дата обращения – 26.04.2021).

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## THE RAUNERS AND THEIR ROLE IN FORESTRY OF RUSSIA

**Abstract.** The article is devoted to the dynasty of Rauners, Russian chemists of German origin who have made such a great affect to the Russian and world science as the development of the current agricultural climatic prediction system, or discovery of climates of different periods of the ancient Earth, or afforestation of mountains in Crimea, which were barren lands only few centuries ago.

**Keywords:** Rauner, forest, charcoal, mining on the Urals, metallurgy, landscape works.

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# РАУНЕРЫ И ИХ РОЛЬ В ЛЕСНОМ ХОЗЯЙСТВЕ РОССИИ

**Аннотация.** Статья посвящена династии Раунеров, русских химиков немецкого происхождения, сделавших такой великий вклад в российскую и мировую науку, как разработка современной сельскохозяйственной системы прогнозирования, или открытие климатов различных периодов древней Земли, или облесение гор Крыма, бывших бесплодными землями только несколько веков назад.

**Ключевые слова**: Раунер, лес, древесный уголь, добыча полезных ископаемых на Урале, металлургия, ландшафтные работы.

Development of forestry in Russia is bound up with the Rauner family, immigrants from Austria, who had been in Russian service from the end of the eighteenth century, and later got Russian allegiance.

The first dynast of the Rauner clan who had connection with forestry was Julius Karlovich Rauner (1818-1888, figure 1), who studied in the Saint Petersburg Mining Institute, and after that in the Lisino Forestry College.

Fig. 1. Julius Karlovich Rauner

After graduation the college, Julius Rauner had been a junior chargemaster of the 1st class at the Ural mining plants, he was a senior draftsman at the chief forester of

the Ural state-owned plants from 1839, the acting forester of the Beryozov Plant from 1840, the head forester of the Bogoslovsky mining district from 1845, the head forester of the Serebryanka Plant of the Goroblagodatsky plants [1-4].

A very important point determining accordance of forestry and metallurgy should be emphasized. A special feature of the mining industry in Russia was its unbreakable connection with forestry, which supplied firewood. The case was in that charcoal provided the best quality of the metal produced in the world. Until the beginning of the 20th century, metallurgy of the Urals was based exclusively on charcoal. The Urals' metal, smelted with aid of firewood, had no harmful impurities and successfully concurred in the world market with European metal trademarks. In addition, wood was used for heating living houses in a harsh climate, building houses, workshops and for much more other applications. Thus, construction and successful managing of mining plants in the Urals and some other mining plants depended primarily on allocation of large forest areas to them [5].

Since the 17th century, there was active damaging of forests near plants of the Urals. Forests assigned to the factories were being registered as so-called "mining plant forest areas" and could be used only for industrial needs. The use of firewood was completely dependent on the mining plant areas, distances from places of timber felling and amount of wood. After felling of those forests were surrounding the mining enterprises, new forest areas widening previous owned lands were being done, and the forest holdings of plant owners expanded. The dependence of mining on this resource base in the Urals was so great that creation of other industries consuming charcoal within the mining districts was strictly prohibited. Preparation of wood stock was carried out by clear cutting, which began directly from a factory's gate. All tree species were used for burning coal, but coniferous wood and birch were preferable. Obliteration of nearby forests led to increasing of price of charcoal due to growth transport costs for its delivery [6].

The Ural factories had to submit to the following law: "A compulsory condition of reasonable use of timber resources must be such economy that annual consumption will be equal to annual growth of wood, because then the descendants will have the same amount as we have received. Irrefutably, felling of excess mass has forests to exhaustion..." [5].

Growing of demand for charcoal in metallurgy urged to accept crash measures of reproduction of forests via natural and artificial restoration and protection of them from deforestation and from forest fires. Intensive forest use in mining plants' forests of the Urals led to the exhaustion of raw near the factories and, in connection with this, surge of price of charcoal. An urgent necessity to find ways to restore nearby forests appeared [7].

Julius Rauner was a forester of the Alagir Silver and Lead Plant in Vladikavkaz, Ossetia from 1850 to 1855. The plant began to work in 1853: from 300 pounds of silver lead, 26 and a half pounds of silver and 264 pounds of pure lead were smelted. The silver bullion received on May 21, 1853 was presented to Nicholas I. The plant's power was assigned for the annual production of 35 thousand pounds of lead and 100 pounds of silver [8, 9].

From 1855, Julius Rauner was a head forester of the Yekaterinburg mining district. As the head forester of the district, he was directly subordinate to the district mining administration, which had all the forests adjacent to the factories under its complete control.

The forests of the Yekaterinburg mining district were divided to five distance ranks, respectively to factories and gold mines in them. The competence and duties of the chief forester included supervision and management of the entire mining district's forestry. He made annual estimations on consumed wood stock, annual reports of their waste, monitored the regular payment to the treasury by wood stock producers for export of timber, he also controlled protection of forests from fires and illegal felling, service by officials of the forest guard, supervised reforestation work [6]...

In the second quarter of the 19th century on the Urals, even at many mining plant areas, there was lack of forest to maintain the industrial process. Necessity of urgent measures to provide continuous supply of firewood for factories and to preserve forest resources. In this regard, an instruction about management of the forests of the mining plants of the Ural ridge according to the rules of forest science and good economy was accepted. It aimed to attend the mining administration to condition of the forestry of the factories, to the measures necessary to improve it [6].

Forester Julius Rauner rose to the rank of colonel, he was awarded by the Order of St. Anne of III rank and Order of St. Stanislaus of II rank, Order of St. Stanislav of II rank with the Imperial Crown [10].

A son of Julius Karlovich Rauner, Stanislaus Yulievich Rauner (1858-1921, figure 2), achieved the greatest fame in forestry as a forester, ameliorator, theorist and practitioner of mining and afforestation works performed in aims of struggle against of soil erosion and mudflows.

Fig. 2. Stanislaus Yulievich Rauner

Stanislaus Rauner was a student of the Forestry Institute in Saint Petersburg from 1879 to 1882. According to the archival materials, from 1880, he repeatedly asked for

a vacation “to relatives” to the Pskov province, to the village of Aleksandrovskoye, to the estate of Konstantin Aleksandrovich van der Bellen. The trips ended with that Stanislaus Rauner married the daughter of the owner of the estate, Natalya Aleksandrovna van der Bellen (1864-1942, a cousin of the current President of Austria). At that time, the estate was the center of attraction for experimenters in area of agriculture and growing crops. Konstantin van der Bellen was deeply involved in the matters of cultivation of cereal crops and breeding cattle, he was not only a good owner, but also a scientist, had great contact with the Timiryazev Agricultural Academy of the Saint Petersburg Forestry Institute. His students were future academicians Pryanishnikov (1865-1948), Williams (1863-1939), Liskun (1873-1958), Lorch (1889-1980) and others [11, 12].

Influence of the forest to condition of a surface and ground waters was the subject of a particularly careful study by Stanislaus Rauner. In 1884, Stanislaus Rauner gets acquainted cotton crop and soil-to-irrigation water, struggle with soil salinization and waterlogging management. His two-year living stay in Egypt was devoted to studying structure of the local irrigation web and improvements made by English engineers in the branch of irrigation. Stanislaus Rauner successfully and thoroughly got acquainted with the nature of the Nile, qua a source of irrigation, and with the rational distribution of water of this river for cultural purposes. In Italy, he studied the irrigation of Lombardy and inspected all the main irrigation channels.

In 1888, Stanislaus Rauner was appointed as a Head of Irrigation and Watering of Province Lands, and then a Head of the Department of Agriculture and State Property in the Turkestan Land. According to the project and methods of struggle against mudflows developed by Stanislaus Rauner, works in the Tashkent area of Turkestan, in particular, irrigation of the northern part of the Hungry Steppe, forestry and hydraulic engineering work in the Akshat Gorge, also on the Georgian military road and the Transcaucasian railway, were performed. “The main task of forestry and hydrotechnical engineering works of Stanislaus Rauner was to prevent the rapid runoff of rainwater or water forming of snow thawing along the steep slopes of a mudflow basin of rivers”. [13-16].

In Crimea, according to a project of Stanislaus Rauner, the Feodosia Mountains were afforested by preliminary amassing of atmospheric precipitation in horizontal drainage ditches. In 1913, for planting trees on Ai-Petri, according to the project of Stanislaus Rauner, ditch terraces were created. The total length of the ditch terraces is 48 km. Even now you can find signs “These forests were planted of an initiative and with participation of Rauner” on Ai-Petri.

Stanislaus Rauner was a full right member of the IRGO (Imperial Russian Geographical Society), an Associate of the Chairman of the Hydrological Committee of the Main Administration of Land Economy and Agriculture, a member of the Permanent Water Measurement Commission in Saint Petersburg, a member of society “Russian Grains” (1908-1917), a Member of the Permanent Ecological Commission of the Imperial Russian Geographical Society [17].

Oblivion, the greatest vice of humanity, is the most distinctive trait of the Soviet and post-Soviet society in relation to people, who did much usefulness for Russia, and positive results of activities of whom are used by modern people. The Rauners are a

typical example of that. People who did so much for Russia, which has become their second homeland, have simply been erased from its history. This publication is intended to refill this gap, at least, partially.

**References:**


1. The Central State Historical Archives in Saint Petersburg, archive fund 963, funding aid 1, archiving 6460, 1841.
2. The Russian State Historical Archives, archive fund 1349, funding aid 4, archiving 306, 1845.
3. The Russian State Historical Archives, archive fund 37, funding aid 45, archiving 1176, 1863.
4. The Russian State Historical Archives, archive fund 37, funding aid 47, archiving 8, 1863.
5. Shumkin, G. N., Zubkov, K. I. *Lesopeomyshlennyy "frontier" gornozavodskogo Urala: plany razvitiya drevesnougolnoy metallurgii regiona v kontse XIX – nachale XX vv.* [Forestry "frontier" of the mining Urals: plans of development of charcoal metallurgy in the region in the late 19th – early 20th centuries] // Genesis: Historical Research, 2019. No. 11, pp. 158-169.
6. Shibayev, V. V. *Organizatsiya upravleniya lesnym khozyaystvom uralskikh gornyh zavodov v XVIII – pervoy polovine XIX vv. Avtoref. dis. kand. ist. nauk* [Organization of forestry management of the Ural mining plants in the 18th century and first half of the 19th century. Extended Abstract of Ph.D. Thesis]. Yekaterinburg, 2012. 28 p.
7. Chernov, N. N. *Istoriya lesnogo dela na Urale: bibliograficheskiye materialy za 1767 – 2008 gg.* [History of forestry in the Urals: bibliographic materials for 1767 – 2008]. Yekaterinburg: The Ural State Forestry Engineering University, 2010. 133 pp.
8. Popov, K. P. *Alagir* [Alagir]. Vladikavkaz.: Ir, 1996. 282 pp.
9. Badov, C. R. *Russkoyazychnoye naseleniye v istorii alagirskogo serebrosvintsovogo zavoda (vtoraya polovina XIX veka)* [Russian-speaking population in the history of the Alagir Silver and Lead Plant (in the second half of the 19th century)] // History, Philosophy, Politics, Cultural Studies and Art History. Tambov: Gramota, 2012. No. 11. Part 2, p. 36-40.
10. *Neskolko slov po povodu konchiny Yuliya Karlovicha Rauner* [Few words in connection with death of Julius Karlovich Rauner] // Yekaterinburgskaya Nedelya, July 31, 1888, p. 640.
11. Bellen K. A. *Zapiska v Ostrovskoy uyezdny komitet o nuzhdakh selskokhozyaystvennoy promyshlennosti ostrovskogo zemlevladeltsa Константина Александровича фон-дер Беллен* [A note to the Ostrovsky district committee on the needs of the agricultural industry of landowner Konstantin Alexandrovich van der Bellen from Ostrov]. Pskov, 1903. P. III-IV
12. Lipin V. A. *A. K. Van-der-Bellen – zabytoye imya v istorii otechestvennoy tsvetnoy metallurgii* [A.K. Van-der-Bellen, a forgotten name in the history of domestic non-ferrous metallurgy] // *Nauchno-Tekhnicheskiye vedomosti SPbGPU* Series.: Science and Education / Ministry of Education and Science of the Russian

Federation; Saint Petersburg State Polytechnic University. Saint Petersburg: 2012. No. 4 (159), pp. 261-262.
13. The Russian State Historical Archives, archive fund 1038, funding aid 1, archiving 221/222, 1889.
14. The Russian State Historical Archives, archive fund 1698, funding aid 1, archiving 86, 1907.
15. The Central State Historical Archives in Saint Petersburg, archive fund 381, funding aid 1, archiving 615, 1914.
16. Rediger A. F. *Istoriya moyey zhizni. Vospominaniya voyennogo mimstra. V dvukh tomakh*. [History of My Life. Reminiscence of a Military Minister. In Two Books]. Moscow. Kanon-Press, Kuchkovo Pole, 1999. 352 pp.
17. Archive of the Russian Geographical Society of the Russian Science Academy, archive fund 86, funding aid 1, 1899-1910.

**Список литературы:**

1. ЦГИА СПб ф. 963, оп. 1, д. 6460. – 1841.
2. РГИА ф. 1349, оп. 4, д. 306. – 1845.
3. РГИА ф. 37, 45, д. 1176. – 1863.
4. РГИА ф. 37, оп. 47, д. 8. – 1873.
5. Шумкин Г. Н., Зубков К. И. Лесопромышленный «фронтир» горнозаводского Урала: планы развития древесноугольной металлургии региона в конце XIX – начале XX вв. // Genesis: исторические исследования. 2019. № 11. – С. 158–169.
6. Шибаев В. В. Организация управления лесным хозяйством уральских горных заводов в XVIII – первой половине XIX вв. Авторефер. дис. канд. ист. наук. Екатеринбург, 2012. – 28 с.
7. Чернов Н. Н. История лесного дела на Урале: библиографические материалы за 1767 – 2008 гг. – Екатеринбург: Урал. гос. лесотехн. ун-т., 2010. – 133 с.
8. Попов К. П. Алагир. – Владикавказ: Ир. – 1996. – 282 с.
9. Бадов Ч. Р. Русскоязычное население в истории алагирского серебросвинцового завода (вторая половина XIX века) // Исторические, философские, политические и юридические науки, культурология и искусствоведение. Вопросы теории и практики. – Тамбов: Грамота, 2012. – № 11. – Ч. 2. – С. 36-40.
10. Несколько слов по поводу кончины Юлия Карловича Раунер // Екатеринбургская неделя, 31 июля 1888. – С. 640.
11. Беллен К. А. Записка в Островской уездный комитет о нуждах сельскохозяйственной промышленности островского землевладельца Константина Александровича фон-дер Беллен. – Псков, 1903. – С. III-IV.
12. Липин В. А. А.К. Ван-дер-Беллен – забытое имя в истории отечественной цветной металлургии // Научно-технические ведомости СПбГПУ. Сер.: Наука и образование / Министерство образования и науки РФ; Санкт-Петербургский гос. политехн. ун-т. – СПб., 2012. – № 4 (159). – С. 261-262.
13. РГИА ф. 1038, оп. 1, д. 221/222. – 1889.
14. РГИА ф. 1698, оп. 1, д. 86. – 1907.

15. ЦГИА СПб ф. 381, оп. 1, д. 615. – 1914.
16. Редигер А. Ф. История моей жизни. Воспоминания военного министра. В двух томах. – М.: Канон-пресс; Кучково поле, 1999. – 352 с.
17. Архив РГО РАН, ф. 86, оп.1, 1899-1910 гг.

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## COMPARISON OF THE EFFICIENCY OF VALVE ELECTRIC MOTORS: REACTIVE AND CONVECTIONAL

**Abstract.** In this article a comparison is made between two valve electric motors operating on reactive and non-reactive thrust in terms of performance, energy efficiency, and operating cost.

**Keywords:** electric motor, efficiency, power, cost, reliability.

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## СРАВНЕНИЕ ЭФФЕКТИВНОСТИ ВЕНТИЛЬНЫХ ЭЛЕКТРОДВИГАТЕЛЕЙ: РЕАКТИВНЫХ И ОБЫЧНОГО

**Аннотация.** В этой статье проводится сравнение двух вентильных электродвигателей, работающих на реактивной и не реактивной тяге по таким параметрам, как производительность, энергоэффективность, а также стоимость эксплуатации.

**Ключевые слова:** электродвигатель, КПД, мощность, стоимость, надежность.

A large number of different types of electric motors are used in the industry today. One of the most common motors is a permanent magnet motor.

A valve motor (VM) is a type of direct current (DC) motor, in which the brush-collector unit is replaced by a semiconductor switch controlled by a rotor position sensor.

There are two types of a permanent-magnet electric motor: a valve reluctance motor (VRM) and a valve synchronous motor (VSM). Let's consider the main advantages and disadvantages of these electric motors.

The valve reluctance motor (VRM) is a brushless synchronous machine, on the stator windings of which voltage pulses of a controlled frequency are applied, creating a rotating magnetic field. The torque arises due to the tendency of the rotor to the position at which the stator magnetic flux passes along the rotor axis with the lowest reluctance. Unlike a brushless synchronous motor, it does not have permanent magnets, that is greatly influenced by the price of the motor.

Advantages and disadvantages of VRM**.**

The rotor and stator are made in the form of packages of sheet magnetic soft material. There are no windings and permanent magnets on the VRM rotor. The phase windings are located only on the stator. To reduce labor intensity the stator winding coils can be manufactured separately, and then put on the stator poles.

It is worth noting the high maintainability. The simplicity of the armature winding increases the maintainability of the VRM, since for repair, it is enough to change the failed coil.

Also, the VRM does not contain permanent magnets either on the rotor or on the stator. On average, with the same electrical, weight and size characteristics, the air-jet engine has a 4 times lower cost, much greater reliability, a wider range of rotational speeds, and a wider range of operating temperatures.

It differs in low heat generation, which occurs mainly only on the stator, therefore additional cooling of the rotor is not required in the operating mode.

The simplicity of the VRM design reduces the labor intensity of its manufacture and higher reliability. Also, the valve jet engine has a wide rotation range, which starts from units to hundreds of thousands of revolutions per minute.

The efficiency of a 1 kW valve reluctance electric motor/generator can reach up to 90 % in the range of 5-10-fold rotation frequency adjustment. The efficiency of more powerful electrical machines can reach 95-98 %. But this efficiency is achieved only at high powers. So, up to 10 W, the efficiency of a valve reluctance motor does not exceed 10 %, and in a few tens of W – 30-40 % [1].

The valve synchronous motor (VSM), in turn, combines the best qualities of alternating current (AC) motors and direct current (DC) motors [2].

Advantages and disadvantages of VSM.

The rotor [3] is made using permanent magnets and usually has two to sixteen pairs of poles with alternating north and south poles. For the manufacture of the rotor, ferrite magnets were previously used, that was determined by their prevalence and cheapness. However, these magnets are characterized by a low level of magnetic induction. Currently, magnets made from rare earth alloys are used extensively, as they allow a higher level of magnetic induction and reduce the size of the rotor.

The stator has a traditional design. It consists of a body, a core made of electrical steel and a copper winding laid in grooves along the perimeter of the core. The winding is divided into phases, which are laid in grooves in such a way that they are spatially shifted relative to each other by an angle determined by the number of phases. It is known two phases to be sufficient for uniform rotation of the motor shaft of an AC

machine. Synchronous machines used in VSM are usually three-phase, however, there are also VSM with four- and six-phase windings.

The range of rotation starts with units and ends at fifteen thousand revolutions per minute [4]. It also has stable efficiency indicators at any power (always above 90 %).

Valve motors are also characterized by some drawbacks, the main of which is their high cost. However, speaking of the high cost, one should take into account the fact that valve motors are usually used in expensive systems with increased requirements for accuracy and reliability. Comparison of engine parameters is presented in table 1 [5].

Table 1

Comparison of engine parameters

| **Parameters** | **VRM** | **VSM** |
|---|---|---|
| **Maintainability** | High | Medium |
| **price** | Medium | High |
| **Reliability** | Very high | Good |
| **Degree of effectiveness** | Medium | Medium |
| **Power** | Up to 300kW | Up to 0,3 kW |
| **Electronics price** | Medium | High |
| **Quality** | Good | Good |

From all of the above, the conclusion can be made that the VRM is best used in systems with high power consumption, so that this type of engine works with maximum efficiency. In turn, the VSM is best used in systems with low power. For the manufacture of VRM, on average, 2-3 times less copper is required. Also, the VRM takes up less space and this allows it to be located in any place.

**References:**


1. *Ventil'nyy reaktivnyy dvigatel'* [Valve jet electric motor]. URL: https://clck.ru/NVZ6j. (date accessed: 15.03.2021).
2. *Ventil'nyy sinchronyy dvigatel'* [Valve synchronous motor]. URL: https://clck.ru/CNazb. (date accessed: 02.04.2021).
3. *Rotor i stator v VSD* [Rotor and stator in VSD]. URL: https://clck.ru/UMuiN (date accessed: 03.04.2021).
4. *Diapazon vrazcheniya dvigatelya* [Engine rotation range]. URL: https://lexsp.ru/ppm.php (date accessed: 10.04.2021).
5. *Sravnenye dvigateley* [Engine comparison]. URL: https://clck.ru/UAJ5w (date accessed: 10.04.2021).

**Список литературы:**
1. Вентильный реактивный электродвигатель. URL: https://clck.ru/NVZ6j (дата обращения: 15.03.2021).
2. Вентильный синхронный двигатель. URL: https://clck.ru/CNazb (дата обращения: 02.04.2021).
3. Ротор и статор в ВСД. URL: https://clck.ru/UMuiN (дата обращения: 03.04.2021).
4. Диапазон вращения двигателя. URL: https://lexsp.ru/ppm.php (дата обращения: 10.04.2021).
5. Сравнение двигателей. URL: https://clck.ru/UAJ5w (дата обращения: 10.04.2021).

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## STUDY OF THE ARTIFICIAL INTELLIGENCE WORK PRINCIPLES ON BASHE GAME

**Abstract.** The work is concerned with the artificial intelligence work principles regarding Bashe game, as well as the process of creating a program which cannot lose the game.

**Keywords**: artificial antelligence, AI, program, computer, game.

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## ИЗУЧЕНИЕ ПРИНЦИПОВ РАБОТЫ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА НА ПРИМЕРЕ ИГРЫ БАШЕ

**Аннотация.** В работе рассматривается принцип работы искусственного интеллекта на примере игры Баше. В результате получается программа, которая не может проиграть.

**Ключевые слова:** искусственный интеллект, ИИ, программа, компьютер, игра.

For several years, government of the Russian Federation pays attention to Artificial Intelligence development in the country. Concerning AI becomes most demand.

The Bashe game is related to a common problem of the game theory. And the basics of the game can be shown through the main stages of AI learning. Idea of winning move computation is based on the ***Sprague-Grundy*** theorems. To answer the question “which move I need to make” it is necessary to compute a condition of the game. Each gamer takes at least one and at most K pieces by turn from N items. Who takes the last one is a winner. The result of the game is determined by the first move if participants do not make mistakes. We can get the winning algorithm if we think from the end backwards, that is, assessing the position before the last move. We need to leave K + 1 items to rival before his/her move [1].

Consider the example using AI of the simplified Bashe game. There are 9 items. A human and a program can remove 1 or 2 items by turn. First one is human. The winner is the player who has only 1 item left before his move.

AI is trained the following way. The program (Fig. 1, Fig. 2) has a massive which has all stages of the game, that is, the massive contains the massive with “1” and “2” values. Every turn a computer chooses an element form the massive at random and makes a sequence of moves in turn starting with this element. If human wins, AI removes that element from the massive. If massive has not the element then it removes element from the previous massive [2].

```
1  import random
2  match = 9
3  bot_match = []
4  bot = [[j for j in range(1, 3) ] for i in range(match-2)]
5  def human_move():
6      print("Всего осталось", match, "спичек")
7      print("Возьмите спички(1 или 2)")
8      human = int(input())
9      while (human != 1 and human != 2 ) or (match - human == 0):
10         print("Возьмите спички(1 или 2):")
11         human = int(input())
12     if human == 1:
13         print("Вы взяли 1 спичку")
14     elif human == 2:
15         print("Вы взяли 2 спички")
16     return human
17
18 def bot_move_fun(match):
19     print("Ход противника")
20     print("Всего осталось", match, "спичек")
21     if bot[match-2] == []:
22         move = random.choice([1, 2])
23     else:
24         move = random.choice(bot[match-2])
25     match -= move
26     if (move == 1 and match == 1) or (move == 2 and match == 0):
27         move = 1
28         print("Противкник убрал 1 спичку")
29     elif move == 1:
30         print("Противник убрал 1 спичку")
31     elif move == 2:
32         print("Противник убрал 2 спички")
33     return move
34
```

Fig. 1. The program, part 1.

```
35
36  while True:
37      match -= human_move()
38      if match == 1:
39          print("Вы выиграли!")
40          for i in reversed(bot_match):
41              if bot[i[0]] != []:
42                  bot[i[0]].pop(bot[i[0]].index(i[1]))
43                  break
44          bot_match = []
45          match = 9
46          print(bot)
47          print("Играем заново")
48          continue
49      bot_move = bot_move_fun(match)
50      bot_match.append([match-2, bot_move])
51      match -= bot_move
52      if match == 1:
53          print("Вы проиграли!")
54          bot_match = []
55          match = 9
56          print("Играем заново")
```

Fig. 2. The program, part 2

```
Всего осталось 9 спичек
Возьмите спички(1 или 2)
1
Вы взяли 1 спичку
Ход противника
Всего осталось 8 спичек
Противник убрал 2 спички
Всего осталось 6 спичек
Возьмите спички(1 или 2)
2
Вы взяли 2 спички
Ход противника
Всего осталось 4 спичек
Противник убрал 2 спички
Всего осталось 2 спичек
Возьмите спички(1 или 2)
1
Вы взяли 1 спичку
Вы выиграли!
[[1, 2], [1, 2], [1], [1, 2], [1, 2], [1, 2], [1, 2]]
Играем заново
Всего осталось 9 спичек
Возьмите спички(1 или 2)
```

Fig. 3. The course of the game

At this scheme (Fig. 3) you can see the full game with AI, and the new massive with all stages after the game as well. That massive will be changed by next games. Finally, we will get AI which cannot lose.

The principle based on this program can be used to educate AI to play other games with similar structures [3]. For example, tic-tac-toe or more complicated games.

Currently, computers' power is increasing and sophisticated neural networks are being built, but it is better to start with simpler examples.

**References**:
1. *Spichechny robot dlya besproigrishnoy igry*. [Match robot for winning game]. URL: https://zen.yandex.ru/media/mp42b/spichechnyi-robot-dlia-besproigryshnoi-igry-ili-nemnogo-pro-obuchaemye-avtomaty-5f71817d63b25d04cdd38f8f (date accessed: 09.04.2021).
2. *Pervonachalnoye oznakomlenye s algoritmamy raboty neyronnoy sety*. [Basics of neural network algorythms]. URL: http://rirorzn.ru/publication/dopolnitelnoe-obrazovanie/pervonachalnoe-oznakomlenie-s-algoritmami-raboty-neyronnoy-seti/ (date accessed: 09.04.2021).
3. *Razvitie tekhnologyi iskusstvennogo intellekta v Rossii*. [Artificial intelligence technology development in Russia]. URL: https://carnegieendowment.org/2020/07/07/ru-pub-82173 (date accessed: 25.04.2021).

**Список литературы**
1. Спичечный робот для беспроигрышной игры. URL: https://zen.yandex.ru/media/mp42b/spichechnyi-robot-dlia-besproigryshnoi-igry-ili-nemnogo-pro-obuchaemye-avtomaty-5f71817d63b25d04cdd38f8f (дата обращения: 09.04.2021).
2. Первоначальное ознакомление с алгоритмами работы нейронной сети. URL: http://rirorzn.ru/publication/dopolnitelnoe-obrazovanie/pervonachalnoe-oznakomlenie-s-algoritmami-raboty-neyronnoy-seti/ (дата обращения: 09.04.2021).
3. Развитие технологий искусственного интеллекта в России. URL: https://carnegieendowment.org/2020/07/07/ru-pub-82173 (дата обращения: 25.04.2021).

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## VALVE CONVERTERS OF DIRECT AND ALTERNATING CURRENT

**Abstract.** This paper discusses the purpose and classification of valve converters, their design and application areas, history, and prospects for the development of converter technology.

**Keywords:** valve converter, electric power, automated drive, valve, DC, AC, semiconductor.

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# ВЕНТИЛЬНЫЕ ПРЕОБРАЗОВАТЕЛИ ПОСТОЯННОГО И ПЕРЕМЕННОГО ТОКА

**Аннотация.** В работе рассматриваются назначение и классификация вентильных преобразователей, их устройство и области применения, история и перспективы развития преобразовательной техники.

**Ключевые слова:** вентильный преобразователь, электроэнергия, электропривод, вентиль, постоянный ток, переменный ток, полупроводник.

In the electric power industry and industry in general, electric power of direct and alternating current is used, which have standard network parameters that are determined by industrial standards. In most cases, the parameters of a standard network in terms of frequency, stability, or voltage level are unsuitable for powering electronic, radio-electronic, and other types of loads. Therefore, in order to coordinate the parameters of the primary source of electricity and its consumers, there is a need to use electric energy converters. According to various sources, 40 % to 60 % of all generated electric power is converted before its use. For example, the type and level of voltage is changed and stabilized. Semiconductor gate converters of electric power are used in transport, electrotechnical installations, and power plants. The widespread use of converter technology devices is due to the advantages of semiconductor devices and microelectronics elements which are small dimensions, high speed, reliability, cost-effectiveness, and wide possibilities of information conversion. Modern conversion technology is based on the use of semiconductor devices, which include: power diodes, thyristors, and various types of power transistors.

Converters made of valves are called valve converters. According to the configuration of the power circuit, valve converters are divided into zero and bridge, and according to the number of phases of the power source – into single-phase and three-phase. Single-phase bridge and three-phase zero circuits, due to the uneven network load and the increased rated power of the transformer, respectively, are used in low-power electric drives (up to 10 kW). In industrial electric drives of medium (from 10 to 2000 kW) and large (more than 2000 kW) power, a three-phase bridge circuit of a valve converter is used, as well as other circuits based on it [1].

Reversible valve converters, unlike non-reversible ones, usually contain two non-reversible converters or a reverser in the armature circuit. Converters with a reverser are used in a low-power machine tool drive. The most widespread are two-component valve converters with counter-parallel connection of valve groups made according to a three-phase bridge circuit. They have a simple two-winding transformer, with a minimum, in comparison with other circuits, design power. In addition, such

gate converters can be powered directly from the three-phase network through linear current-limiting reactors, and also allow the design of reversible and non-reversible converters to be unified. In addition to the counter-parallel ones, cross-circuits of gate converters are used, which have only one equalizing current circuit, as well as lower power and mass of equalizing reactors. A variety of cross-valve converters is an H-circuit with a single equalizing reactor. Reversible valve converters with two sets of valves can operate in separate and joint control modes. A separate control is used in cases where, according to the operating conditions of the drive, a pause in its control with an approximate duration of 5 to 10 ms is allowed, which is necessary to turn off the thyristors of the thyristor group that is leaving the operation. This makes it possible to dispense with equalizing reactors, which are necessary to limit equalizing currents in the joint control mode, and to reduce energy losses in the valve converter, which is especially important for high-power electric drives. Pulse-phase control systems of valve converters are usually made according to the vertical principle and have several control channels. Each of the channels contains a reference voltage generator, a comparator, and a pulse generator. In reversible valve converters, the control device, in addition to the pulse-phase control system for valve groups, also contains a logical switching device that performs automatic switching of these groups [2].

Valve DC converters also serve to supply the field windings and anchor circuits of DC motors in the case when it is required to have a large speed control range and high quality of the transient modes of the electric drive. For these consumers, the power circuits of valve converters can be: zero or bridge, single-phase or three-phase. The choice of a particular converter circuit must be based on:

1) ensuring acceptable ripples in the rectified voltage curve;

2) limits on the number and magnitude of higher harmonic voltages in the AC network;

3) high power transformer usage [3].

It is well known that the pulsating rectified voltage of the converter creates a pulsating motor current that disrupts the normal switching of the motor. In addition, voltage ripples cause additional losses in the engine, which leads to the need to overestimate its power. Improving the switching and reducing losses in the electric motor can be achieved either by increasing the number of phases of the rectifier, or by introducing a smoothing inductance, or by structurally improving the motor. If the converter is designed to power the anchor circuit of the motor, which has a low inductance, the most rational of its power circuits are three-phase: double three-phase zero with an equalizing reactor, bridge. To supply the field windings of DC motors with significant inductance, the power circuits of valve converters can be either three-phase zero, or single-phase or three-phase bridge. For high-power electric drives, the reduction of rectified voltage ripples is achieved by parallel or serial connection of the rectifier bridges. In this case, the rectifier bridges are powered either from one three-winding transformer or from two two-winding transformers [4].

Currently, unmanaged semiconductor, controlled, avalanched, symmetric, and high-frequency valves for high currents and voltages have been developed, and their production has been established. Production of semiconductor converters for the valve drive of direct and alternating current, excitation of powerful generators, charging of

accumulator batteries, power supply of electrolytic baths of electroplating shops, traction substations, electrolysis in the chemical industry, and also for use in other branches of the national economy is mastered.

Converter equipment today is an integral part of such branches of electrical engineering as power supply, electric drive and household electrical engineering.
Power electronics devices today have a huge potential in terms of increasing their unit power and reducing losses. But the main goal is to reduce the harmful effects of gate converters on the network and to increase the quality of voltage at the expense of gate converters. The mass replacement of analog control systems with direct digital control systems has become inevitable due to the enormous increase in the degree of integration of digital elements of control systems. The most advanced control systems in our time are integrated with executive motors and power converters into a single unit – a mechanical motion module. Due to a significant reduction in the power of control systems, noise immunity becomes a serious problem that requires special attention.

Currently, the greatest financial costs are not required for the development of hardware, but for the creation of algorithmic and software. Due to the rapidly increasing complexity of electromechanical devices, the most important role is and will be played by the rapid introduction of computer and information technologies in the development, design, production, and operation of electrical equipment.

**References:**


1. *Energeticheskie pokazateli preobrazovatelia* [Energy indicators of the converter]. URL: https://cyberpedia.su/8xc7c9.html (date accessed: 21.04.2021).
2. *Tipy ventilnykh preobrazovateley, oblasti primeneniya, struktury system upravleniya* [Types of valve converters, applications, control system structures]. URL: https://student2.ru/matematika/535145-tipy-ventilnykh-preobrazovateley-oblasti-primeneniya-struktury-sistem-upravleniya/ (date accessed: 21.04.2021).
3. *Preobrazovatelnaya tekhnika* [Conversion technology]. URL: https://studfile.net/preview/10003128/page:2/ (date accessed: 26.04.2021).
4. *Raschet parametrov i vybor preobrazovatelnogo transformatora* [Calculation of parameters and selection of the converter transformer]. URL: https://infopedia.su/18x10921.html (date accessed: 27.04.2021).


**Список литературы:**


1. Энергетические показатели преобразователя. URL: https://cyberpedia.su/8xc7c9.html (дата обращения: 21.04.2021).
2. Типы вентильных преобразователей, области применения, структуры систем управления. URL: https://student2.ru/matematika/535145-tipy-ventilnykh-preobrazovateley-oblasti-primeneniya-struktury-sistem-upravleniya/ (дата обращения: 21.04.2021).
3. Преобразовательная техника. URL: https://studfile.net/preview/10003128/page:2/ (дата обращения: 26.04.2021).
4. Расчет параметров и выбор преобразовательного трансформатора. URL: https://infopedia.su/18x10921.html (дата обращения: 27.04.2021).

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## SORPTION PROPERTIES OF POLYAMPHOLYTE HYDROGELS

**Abstract.** The article describes the results of the work, wherein amphoteric hydrogels were obtained using a simpler procedure without an initiator and a crosslinking agent. The dependences of the sorption capacities of the obtained hydrogels on the pH of the medium and the concentration of indigo carmine were established. It has been shown that at temperatures above 60 °C, syneresis of polymer networks of hydrogels is observed.

**Keywords:** polyampholyte hydrogel, sorption, polyacrylamide, indigocarmine, aliphatic diamine.

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## СОРБЦИОННЫЕ СВОЙСТВА ПОЛИАМФОЛИТНЫХ ГИДРОГЕЛЕЙ

**Аннотация.** В результате данного исследования были получены гидрогели амфотерного типа по более простой методике без использования инициатора и сшивающего агента. Установлены зависимости сорбционных емкостей полученных гидрогелей от pH среды и концентрации индигокармина. Показано, что при температуре выше 60 °C наблюдается синерезис полимерных сеток гидрогелей.

**Ключевые слова:** полиамфолитный гидрогель, сорбция, полиакриламид, алифатический диамин, индигокармин.

Today, on account of global environmental pollution, the issue of wastewater treatment, which is daily discharged in large quantities by industrial enterprises, is becoming more and more acute. For each individual case, the selected sorbent must meet a number of requirements regarding its properties: from chemical and physicomechanical properties to regeneration and utilization of the sorbent. It is also

problematic to obtain imported sorbents, since they are synthesized according to long-term multistage methods with preliminary purification of the initial reagents, using catalysts and cross-linking agents, as well as with high energy consumption. Polyampholyte hydrogels obtained in a simpler way can become optimal replacements for ineffective sorbents [1, 2].

Thus, the aim of this work is to obtain amphoteric hydrogels without the use of an initiator and a crosslinking agent based on a cationic polymer and aliphatic diamines, as well as to study their main properties.

Polyampholytic hydrogels were obtained by the interaction of partially hydrolyzed polyacrylamide with ethylenediamine and 1.3-diaminopropane. Hereinafter, hydrogels obtained on the basis of these aliphatic diamines will be referred to as EDA and PDA, respectively.

Polyampholytes are a unique class of polyelectrolytes that combine both negatively and positively charged monomer units in their structure. Due to their interactions, in aqueous media polyampholytes exhibit many specific properties that can be completely different from the properties of the corresponding polyelectrolytes containing the same charged groups, but only of one sign [3].

The calculation of the sorption capacity of the hydrogel was carried out according to the formula 1:

$$q_e = \frac{V(C_1 - C_2)}{W}, \quad (1)$$

where V is the dye solution volume, l;
$C_1$ is the concentration of the dye in the solution before immersing the hydrogel in it, mg/l;
$C_2$ is the concentration of the dye in the solution after the hydrogel is immersed in it, mg/l;
W is sample weight, mg.

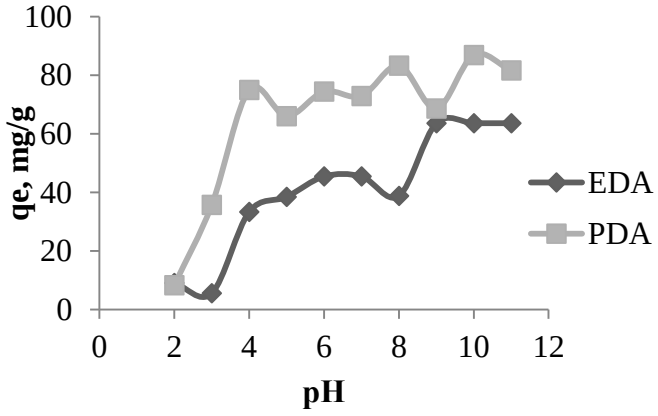


Fig. 1. Dependence of the sorption capacity of polyampholyte hydrogels on the pH of the indigo carmine solution

Fig. 1 shows that the sorption capacity of PDA is greater than that of EDA. The larger the macromolecule of the polyampholyte hydrogel, the more the groups on its surface that are capable of binding the macromolecule to several ionogenic groups of the dye. Thus, PDA adsorbs better than EDA due to the presence of additional groups in the structure that increase the size of the macromolecule.

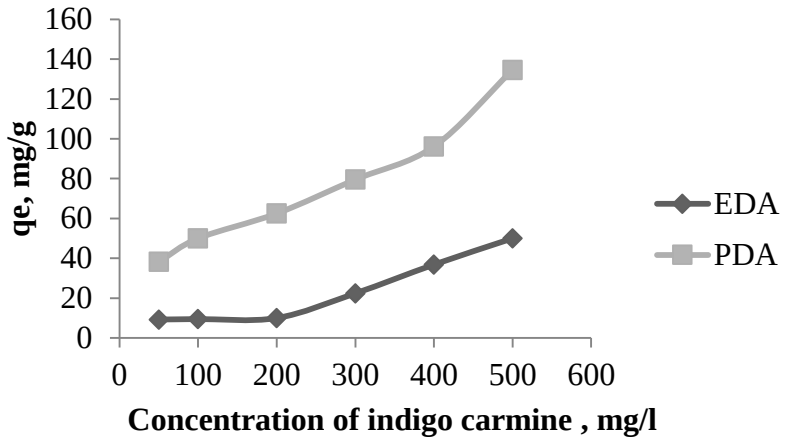


Fig. 2. Dependence of the sorption capacity of polyampholyte hydrogels on the concentration of indigo carmine solution

Fig. 2 shows that with an increase in the concentration of indigo carmine, the sorption capacity of both hydrogels also increased. However, the PDA hydrogel absorbed the dye from solution better than the EDA hydrogel. The growing sorption capacity is associated with the appearance of a large number of indigo carmine ions, which the hydrogel can absorb. The sorption of the PDA hydrogel is significantly higher than that of EDA, due to the large size of the sorption cell of the polymer network in comparison with that of the EDA hydrogel.

The calculation of the degree of swelling of the hydrogel was carried out according to formula 2:

$$Y = \frac{m_2 - m_1}{m_1} * 100\%, (2)$$

where $m_1$ is the mass of the hydrogel sample before swelling, g;
$m_2$ is the mass of the hydrogel sample after swelling, g.

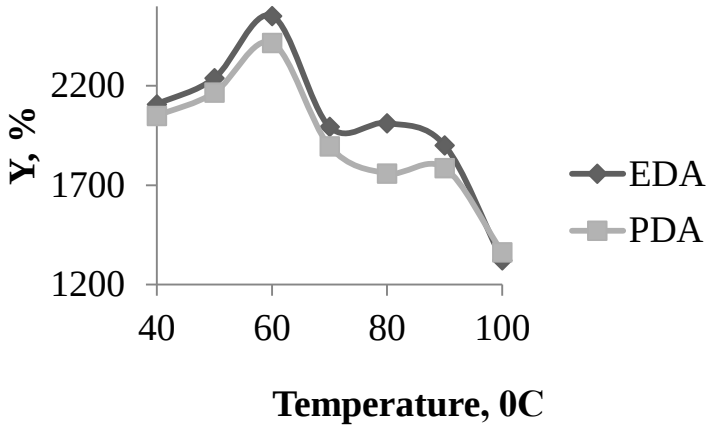


Fig. 3 Dependence of the degree of swelling of polyampholytic hydrogels on temperature

It can be seen in Fig. 3 that hydrogels achieve the greatest swelling at 60 °C, and in the range 70-100 °C, the degree of swelling decreases sharply. Such a noticeable dependence of the volume of polymers can be caused by the following reasons. In the absence of a solvent, polymer chains are "folded" into a ball, since in this case the most "ordered" conformation of the structure takes place. Upon the incorporation of solvents into polymer networks of hydrogels, polymer chains unfold, which corresponds to the growth of disordered fragments. However, at temperatures above 60 °C, the destruction of the polymer network occurs, which leads to a decrease in the degree of swelling, since the structure of polyampholyte hydrogels becomes more rigid.

*Conclusions:*

1. Amphoteric hydrogels were obtained byusing a simpler technology without an initiator and a crosslinking agent.

2. The sorption capacity of hydrogels was measured at different levels of pH and it follows from the obtained results that the studied polyampholyte hydrogels can be used to remove colored organic impurities in wastewater.

3. The dependence of the degree of swelling of the studied polyampholyte hydrogels on temperature was investigated and showed the highest degree of swelling of both hydrogels at a temperature of 60 °C, above which the thermal destruction of the polymer begins.

**References:**

1. Mirtič, J. (2020) Polyelectrolyte-surfactant-complex Nanoparticles as a Delivery Platform for Poorly Soluble Drugs: A Case Study of Ibuprofen Loaded Cetylpyridinium-alginate system. *International Journal of Pharmaceutics*.
2. Towle, El. (2020) Impact of Molecular Weight on Polyelectrolyte Multilayer Assembly and Surface Properties. *Journal of Colloid and Interface Science.* 1 (570), pp. 135-142.
3. Benbow, N. (2020) Lysozyme Uptake into Pharmaceutical Grade Fucoidan / Chitosan Polyelectrolyte Multilayers Under Physiological Conditions. *Journal of Colloid and Interface Science.*

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## THE PROSPECTS FOR THE DEVELOPMENT OF PULP AND PAPER INDUSTRY IN RUSSIA

**Abstract.** This paper discusses the prospects of the pulp and paper industry in Russia. Consequently, two main points are considered: preconditions for its growth and current support solutions in our country.

**Keywords**: forest-based industries, pulp and paper industry, economic forecast, capacity.

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## ПЕРСПЕКТИВЫ РАЗВИТИЯ ЦБП В РОССИИ

**Аннотация**. В работе рассматриваются перспективы развития целлюлозно-бумажной отрасли в России. В результате проведенного исследования рассказывается о предпосылках развития и о нынешних решениях по поддержке ЦБП в нашей стране.

**Ключевые слова:** лесообрабатывающая промышленность, целлюлозно-бумажная промышленность, ЦБП, прогноз развития, объём производства.

Forest-based industries in general and pulp and paper industry in particular are of great importance to the Russian Federation. Due to the scale of the country, about 46.6 % of its land is covered with forests. Russian government can increase their tax income by developing these large areas. However, it is not the only reason to invest in this sector. Let us consider them in more detail.

First, selling wood is not as profitable as selling pulp, but selling pulp is not that profitable as selling paper. Thus, the main reason why paper should be sold to the global market is its higher added value. The second reason is that cellulose fibers are bio-degradable. Synthesized polymers take more time to decompose than cellulose. The share of the paper packaging is growing which leads to driving some polymers out of the packaging sector. The third reason is that developing this area will create more employment opportunities. Finally, a wide range of products can be produced from

pulp or new materials can be created. The development of this sector opens up new opportunities for the country; nevertheless, there are problems that slow down its growth.

Pulp and paper industry is full of complicated technological processes. It produces not only pulp, which is required in papermaking or chemical facilities, but also a lot of by-products such as liquid rosin, fodder yeast, sulfate lignin, tall oil, methanol, turpentine and heat [1]. Not all of these by-products have been produced efficiently at pulp and paper mills in Russia. There are ways to increase the output of those extra products without decreasing production rate and quality of the main product. It is due to many reasons such as government legislation, lack of manufactures that would consume those by-products, profitability of these products, imperfect logistics and technologies and insufficient investment. As we can see, there are a lot of problems.

Nowadays the Russian Federation exports around 84 % of market pulp and 50 % of paper and paperboard. This gives around 5 % of foreign exchange earnings from these facilities. There is sufficient competitiveness in the domestic market and medium competitiveness in the global market. In the domestic market, there is always competition with imported goods. For example, the weakest spot is coated paper.

Pulp and paper industry can become one of the key elements of the Russian economy, but due to technical condition and its share in the national economy, it leaves room for improvement. Nowadays there are 212 facilities in the pulp and paper sector. 17 of them are producing more than 100 thousand tons per year – it's about 79.9 % of the overall volume. Fourteen factories are having the capacity of 50 thousand tons per year – 9.5 %. Other 181 facilities comprise 9.6 % from the overall volume. This means that there is uneven distribution between the facilities [2, 3].

The main reason why Russia cannot be competitive on the global market, is the use of outdated technological processes and the average age of the operating equipment which is more than 40 years old. This leads to having poor capacity with higher expenses. More than 60 % of all mills in the Russian Federation were founded in the 1920-1930s. Around 30 % were founded in 1950s. Others were founded in 1950-1960s and produce 86 % of the country's volume of paper and paperboard [2, 3].

The imperfection of Russian legislation has a very strong impact on the economy as a whole and on the work of the pulp and paper industry in particular. To a large extent, because of this, enterprises lose their working capital. The lack of state regulation of the economy led to sharp price distortions, tax policy created unfavourable conditions for domestic producers, there was an outflow of financial capital to the underground economy and abroad, state support for exports and protection against imports could be called rather weak.

For this reason, a number of business leaders, realizing the need to combine their efforts to work together, established the Russian Association of Pulp and Paper Organizations and Enterprises "RAO BUMPROM", which later led to the state's supporting the development of the pulp and paper mills of Russia starting from 2008. In addition, a book "Best Available Techniques in the Pulp and Paper Industry" was published, which is a reference guide offering standardization, developed as a result of the analysis of technological, technical and management solutions used in the

production of pulp, paper and paperboard. It aims at helping producers to introduce modern technologies to the existing technological processes.

There is a forecast for production volume of paper and paperboard that shows three possible scenarios:

1. innovative scenario (the best possible one);
2. moderate scenario;
3. inertia scenario (the worst expected one), see Fig. 1.

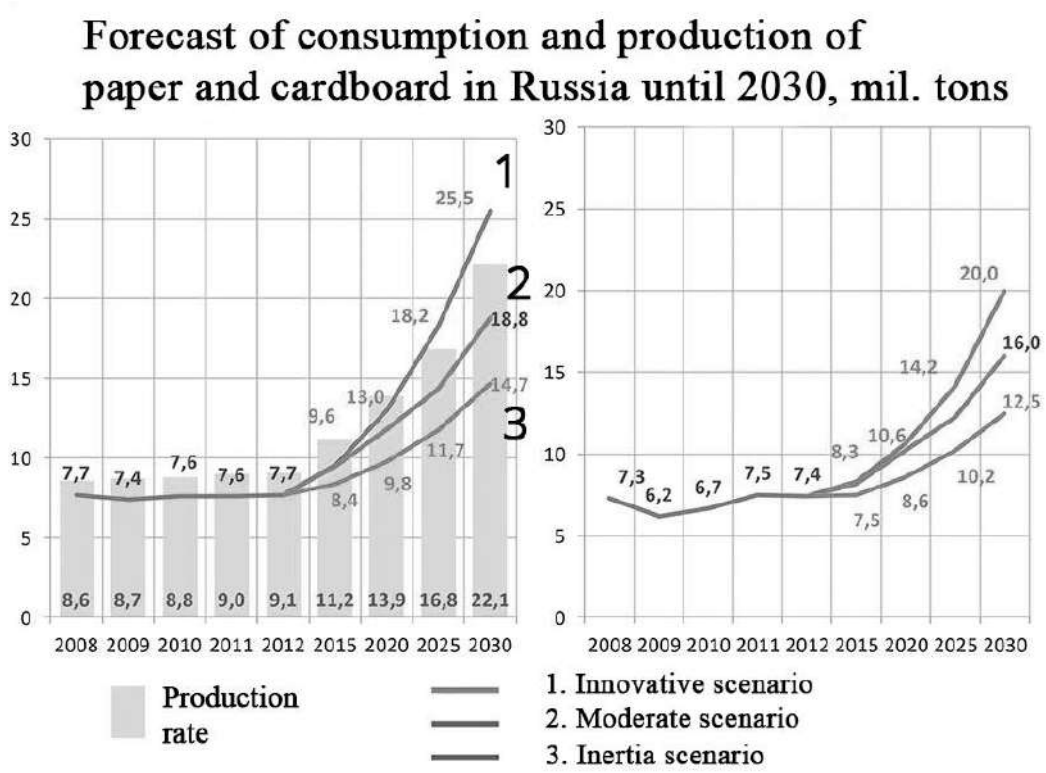


Figure1. Forecast of consumption and production of paper and cardboard in Russia until 2030

This forecast shows how the capacity will change each year until 2030. In 2020 the production capacity was 9.5 mil. tons of paper and paper board. As we can see it is a bit lower than it was expected by the inertia scenario. This low value comes from the global pandemic problem. During this time the capacity has been decreased due to low consumption.

There are a lot of problems in Russian pulp and paper sector, from importing outdated high-quality equipment, that makes the goods produced less valuable and less competitive on the domestic and global market, to research and development (no new technologies have been created in recent years) and lack of highly qualified workforce.

The reasonable question is what measures can be taken to increase the share of this sector and thus to improve the economy in general?

First, it is necessary to ensure the effective use of the existing capacities, the creation of new capacities and new production facilities for the manufacture of competitive products. Second, it is essential to make greater use of the domestic

scientific and technical potential. Third, it is very important to focus the customs and tariff policy on the growth of the national production and increasing competitiveness. Fourth, tax policy has to be improved. Fifth, more high-yield technologies can be used. Sixth, the efficiency by-product manufacture should be increased, which in turn will lead to the improvements in other fields such as chemical and pharmaceutical industries and many more. Finally, Russian pulp and paper giants should be interested in creating new specialists for their industry by offering internship for students. All this would provide a promising future for the pulp and paper industry in Russia.

**References:**


1. *Tekhnologiya Cellyulozno-bumazhnogo proizvodstva. V 3 t. T. I. syr'e i proizvodstvo polufabrikatov. CH. 2. Proizvodstvo polufabrikatov* [Technology of Pulp and Paper Manufacture. In 3 vol. Vol.1 Raw materials and Production of Semi-finished products. Part 2. Production of Semi-finished Products]. SPb, 2003, 633 p. (in Russian).
2. *Rossijskaya Associaciya organizacij i predpriyatij cellyulozno-bumazhnoj promyshlennosti (RAO "Bumprom")* [Russian Association of Pulp and Paper Organizations and Enterprises "RAO BUMPROM"). URL: https://bumprom.ru/
3. Dubina, N. *Cellyulozno-bumazhnaya promyshlennost' v Rossii: vchera, segodnya, zavtra* [Pulp and Paper Industry in Russia: Yesterday, Today, and Tomorrow]. URL: https://compuart.ru/article/24982


**Список литературы:**


1. Технология целлюлозно-бумажного производства. В 3 т. – Т. I. Сырье и производство полуфабрикатов. – Ч. 2. Производство полуфабрикатов. – СПб.: Политехника, 2003. – 633 с.
2. Российская Ассоциация организаций и предприятий целлюлозно-бумажной промышленности (РАО «Бумпром»). URL: https://bumprom.ru/
3. Дубина Н. Целлюлозно-бумажная промышленность в России: вчера, сегодня, завтра. URL: https://compuart.ru/article/24982

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## OSMOTIC HYDROELECTRIC POWER PLANTS: ALTERNATIVE ENERGY SOURCE FROM SEAWATER

**Abstract.** Seas, rivers and lakes are inexhaustible sources of energy, not only do the set the movement of the turbines of tidal and hydroelectric power plants, but they also are able to provide energy to osmotic stations. In our study we will consider the operation of such stations, which is based on a change in the salinity of water

**Keywords:** osmosis, energy, osmotic power plants, alternative energy sources, hydroelectric power plants.

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## ОСМОТИЧЕСКИЕ ГИДРОЭЛЕКТРОСТАНЦИИ: АЛЬТЕРНАТИВНЫЙ ИСТОЧНИК ЭНЕРГИИ ИЗ МОРСКОЙ ВОДЫ

**Аннотация.** Моря, реки и озера – неиссякаемые источники энергии, они задают движение турбинам не только приливных электростанций и гидроэлектростанций, но и способны обеспечить энергией осмотические станции. В нашей статье мы рассмотрим принцип работы таких станций, которые, как ни странно, основаны на изменении солености воды.

**Ключевые слова:** осмос, энергия, осмотические электростанции, альтернативные источники энергии, гидроэлектростанции.

The study of alternative energy sources, for example, thermal, light, kinetic, electrical, chemical energy, and so on, is at the forefront of energy production today. With the development of science and technology, another way of generating energy has been discovered. We are talking about a prototype of a hydroelectric power plant that operates on the basis of osmosis. Osmosis is the process of spontaneous transfer of a solvent through a semipermeable membrane, whose molecules are transferred towards a substance with a higher concentration. This hydroelectric power plant was

first used on November 24, 2009 in Tofte, Norway, thus Norway became the first country to convert salt energy into electricity [1].

An osmotic power plant is a hydroelectric power plant that works on the principle of mixing fresh and marine water. The principle of operation of the osmotic power plant is based on a long-known physical process, osmosis or, simply put, on diffusion, that is, fresh water molecules penetrate into salt water molecules, from a substance with a lower concentration to a substance with a higher concentration. It is important to note that in osmotic power plants, the soluble substance is sea salt. Therefore, the principle of operation of the osmotic electric power plants (OEPPs) is as follows: salt and fresh water solutions located in one common vessel are separated by a permeable membrane, due to different concentrations of solutions, osmotic pressure occurs, and after a while the water level in the vessel becomes different. The semipermeable membrane holds the salts, resulting in an excessive pressure in the seawater part, which is raised by the current of fresh water continuously flowing through the membrane into the seawater compartment. For a better understanding of the principle of operation of the OEPP, see the figure below (Fig. 1.) [2]:

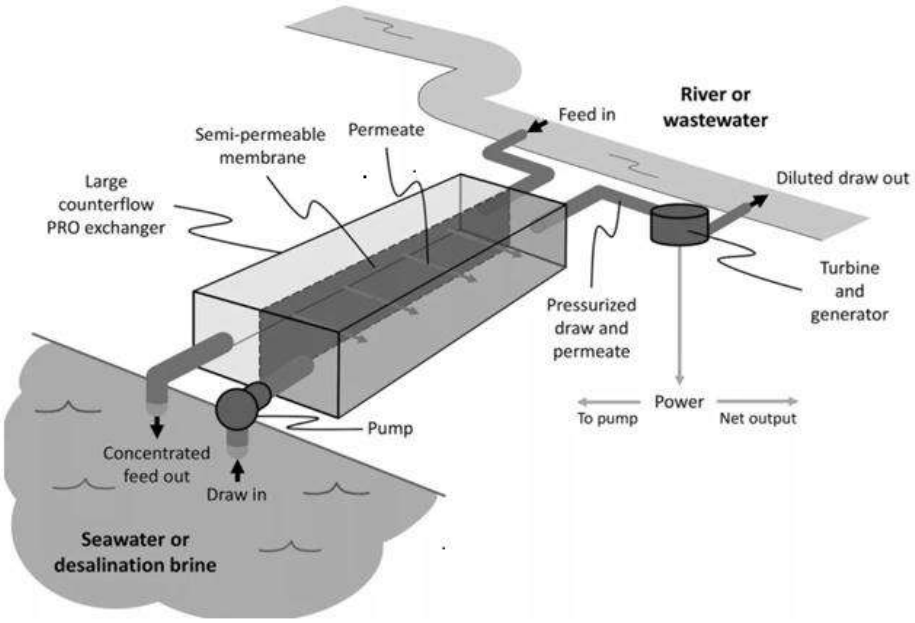


Fig. 1. Scheme of osmotic hydroelectric power plant

If we consider the osmotic membrane separately, then in essence it looks like a bundle or roll placed in a cylindrical body (Fig. 2.). It has a multi-layered structure, within which the levels of fresh and salt water alternate. The more such structures are installed at the station, the more energy the station will be able to generate, because the system capacity will increase, which will lead to an increase in overpressure. Water is drawn out of the reservoir and gives movement to the impeller of the hydraulic turbine, which generates energy [3].

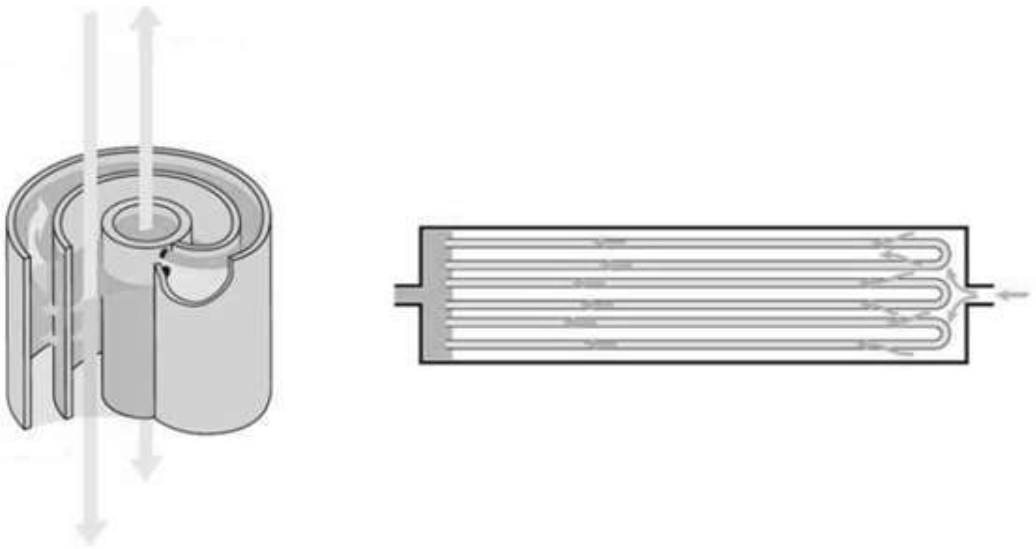

Fig. 2. Osmotic membrane

It is important to note that the membrane has two main characteristics: selectivity and permeability. Basically, the turbines produce mechanical energy not as a result of the pressure drop, but just because of the water flow. The osmotic membrane used must be able to contain high pressure and be of high porosity, as well as contain salt molecules. Such a set of conflicting requirements has long stopped scientists from using osmosis for energy-related purposes.

Electricity at the OEPP can be generated using only seawater. With the help of highly efficient membranes, it is possible to utilize the energy of the ocean depths, since the indicator of the salt concentration in the water depends on the depth. Nevertheless, the operating principle does not change when this method of generating electricity is used.

In terms of efficiency, the osmotic power plant is less productive than biofuel plants, solar panels and wind turbines, but more efficient than tidal hydroelectric power plants.

Let us consider the advantages of an osmotic power plant:

1. OEPP-systems are very resistant to any weather conditions, such as wind or sun, which compares them favourably with wind, solar, or tidal power plants.

2. Their operation is characterised by the absence of toxic substances, so that the OEPP can be located on the remoter areas of the city, without causing damage to its residents. Therefore, there is no need in building stations in special areas, since they do not pose threat to the environment.

3. The bioresources used for the operation of the osmotic station are renewable.

4. Sea and fresh water are easily accessible and are in large quantities, so another advantage of OEPP is cheap raw materials.

5. Such hydroelectric power plants always produce a predictable amount of energy.

Of course, the osmotic power plant has its drawbacks:

1. Due to the peculiarity of the operating principle of the OEPP, it can only be used near the seacoasts. The impracticability of its widespread use is due to the lack of sea and fresh water in one location at the same time.

2. Low power installations (about 2-5 kW).

3. Semi-permeable membranes must be cleared from organic residues that remain in micropores, despite the fact that sea water is taken from a depth of more than 35 meters [4].

Osmotic hydroelectric power plants can operate continuously, regardless of weather conditions, which makes them superior to other types of alternative energy sources. The solution of the problem of development of high-efficiency membranes will allow this energy source to play a big part in the provision of electric energy to the areas located on the seacoasts.

**References:**


1. *Osmoticheskaya elektrostantsiya: al'ternativnaya energiya iz morskoj vody* [Osmotic Power Plant: Alternative Energy from Marine Water]. URL: https://oko-planet.su/science/sciencenews/375285-osmoticheskaya-elektrostanciya-alternativnaya-energiya-iz-morskoy-vody.html. (date accessed: 15.04.2021). (in Russian).
2. *Istoriya sozdaniya sistem obratnogo osmosa. Industriya razvitiya membrannyh fil'trov v mire* [The History of Creation of the Reverse Osmosis. The Industry of Development of Membrane Filters].URL: https://water-service.com.ua/chto-interesnogo/istoriya-sozdaniya-obratnogo-osmosa.html. (date accessed: 15.04.2021). (in Russian).
3. *Osmoticheskaya elektrostantsiya* [Osmotic Power Plant]. URL: https://втораяиндустриализация.рф/osmoticheskaya-elektrostantsiya/ (date accessed: 18.04.2021). (in Russian).
4. *Solenyj kilovatt: osmos* [Salty Kilowatt: Osmosis]. URL: https://www.popmech.ru/technologies/11203-solenyy-kilovatt-osmos/#part1. (date accessed: 18.04.2021). (in Russian).


**Список литературы:**


1. Осмотическая электростанция: альтернативная энергия из морской воды. – URL: https://oko-planet.su/science/sciencenews/375285-osmoticheskaya-elektrostanciya-alternativnaya-energiya-iz-morskoy-vody.html (дата обращения: 15.04.2021).
2. История создания систем обратного осмоса. Индустрия развития мембранных фильтров в мире. – URL: https://water-service.com.ua/chto-interesnogo/istoriya-sozdaniya-obratnogo-osmosa.html (дата обращения: 15.04.2021).
3. Осмотическая электростанция. URL: https://втораяиндустриализация.рф/ osmoticheskaya-elektrostantsiya/ (дата обращения: 18.04.2021).
4. Соленый киловатт: осмос. URL: https://www.popmech.ru/technologies/11203-solenyy-kilovatt-osmos/#part1 (дата обращения: 18.04.2021).

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## APPLICATION OF GEOTHERMAL ENERGY IN POWER ENGINEERING

**Abstract.** The article considers the use of geothermal energy in industrial power engineering. The advantages and disadvantages of this energy source are given.

**Keywords:** geothermal energy, power engineering, geothermal power plant, Earth's heat.

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## ПРИМЕНЕНИЕ ГЕОТЕРМАЛЬНОЙ ЭНЕРГИИ В ЭНЕРГЕТИКЕ

**Аннотация.** В статье рассматривается применение геотермальной энергии в промышленной энергетике. Приводятся недостатки и достоинства данного источника энергии.

**Ключевые слова**: геотермальная энергия, энергетика, геотермальная электростанция, тепло Земли.

In the last decade, the use of non-traditional renewable energy sources has become more and more popular. This direction is developing most intensively in comparison with other areas of energy [1; 57]. There are several reasons for the growth in popularity. Firstly, the rise in prices for all types of traditional energy sources. Secondly, the desire of many countries deprived of their fuel base for energy independence. And thirdly, environmental considerations play a significant role, including the emission of harmful gases. Active moral support for the use of non-traditional renewable energy sources is provided by the population of developed countries, such as the USA, Japan, the Philippines, Italy, Iceland. Geothermal sources are one of the promising areas of getting energy. It is noteworthy that 26.5 % of Iceland's electricity is generated by geothermal energy, 90 % of heating and hot water is also heated at its expense. So, with the help of geothermal energy, Iceland got out of the economic crisis of 2006 and it plans to become a country completely independent of energy hydrocarbons in 2050 [2].

The most potential sources of geothermal energy include the heat of the earth, the energy of the earth's rotation, the energy of the decay of radioactive elements, the energy of meteorites, and physicochemical tectonic processes in the bowels of the earth's crust. They can be divided into hydrothermal and petrothermal energy. The first uses the thermal energy of the Earth's interior, the second – the difference in soil temperatures on the surface and in the depths of the Earth. The temperature of the earth's outer layer of soil depends on external sources, such as the sun. At a depth of about ten to hundreds of meters, the soil temperature is equal to the average annual temperature of the Earth's surface and is kept constant. And from a certain depth, which is different for each point of the planet, internal energy begins to prevail over external sources of heat, and the deep layers of the earth's crust are heated from the core of the Earth [3; 45].

Geothermal power industry is also developed in Russia. The first geothermal power plant in the USSR was the Pauzhetskaya Geothermal Power Plant, which began operation in 1967. At the moment, it is the main producer of electricity and partly heat for the life support of the south of the Kamchatka Peninsula – the villages of Ozernovsky, Pauzhetka and Zaporozhye. After the Pauzhetskaya station, the Paratunskaya Geothermal Power Plant, the world's first binary power plant, was put into operation. Further development of binary power cycles continued with the use of ammonia-water mixture as an intermediate working fluid (instead of freons), which more than doubled the efficiency of binary power plants.

The first such station was built in 1992 abroad – in the city of Los Angeles. In 1987, after large-scale studies of geothermal deposits, it was decided to commission a new Geothermal Power Plant, Mutnovskaya, in ten years. But the plans were not destined to come true, since the USSR collapsed. But the construction began in the 2000s and in 2001 the first block of the power plant was put into operation. To date, the Mutnovskaya power plant is the largest and most powerful geostation in Russia. Together with the old Verkhne-Mutnovskaya GTPP, this production supplies electricity to a third of the Kamchatka Peninsula [4; 8].

The binary cycle has been studied on a large scale. Consider the principle of operation of this cycle using the example of the Mutnovskaya GTPP. But first, let's determine how the heat inside the Earth is generally converted into energy. Water is pumped underground through a special injection well. A kind of underground pool is formed, which acts as a heat exchanger. The water in it heats up and turns into steam, which is fed through the production well to the turbine blades connected to the generator axis. But despite the apparent simplicity of the process, operational problems arise: the need to clean geothermal water from dissolved gases, since gases destroy pipes and negatively affect the environment; loss of part of the energy from the condenser due to the high boiling point of water. The binary loop is devoid of these drawbacks. In addition to steam, hot water is also supplied from the wells. Water heats an organic heat carrier (freon) with a low boiling point. Freon boils, turns into steam, which rotates the turbine. Then, freon condenses and returns again for subsequent heating; the cycle is closed. Thus, the station has two circuits (hence the name – binary), although generally speaking, there is also a third circuit – in the condenser, freon is cooled by running water from the river. As a result, emissions of harmful

substances into the atmosphere are minimized; a higher efficiency of the installation is achieved; it is possible to use water with a temperature below 100 °C.

There are some advantages of geothermal power plants:

1. Efficiency. Such structures do not require auxiliary fuel sources for operation, so there is an opportunity to save money on its delivery.

2. Safety and environmental friendliness. Geothermal power plants do not emit harmful substances, thereby allowing not to worsen the ecological situation.

3. Self-sufficiency. Fuel delivery is needed only to start the operation of the geothermal power plant. In the future, the power plant provides itself with electricity.

4. Profitability. Such power plants do not require large cash costs: investments are required only for preventive inspections, scheduled maintenance, and repairs [3; 77].

But the GTPP also has disadvantages:

1. Difficulties in the development of the project. Problems arise at all stages of design: finding a suitable place, testing, obtaining permission from the authorities and the local population.

2. Work stoppage at any time. The work of the station can stop even due to natural changes in the earth's crust. It is impossible to predict this. An unsuccessful choice of location for the construction of the Geothermal Power Plant also does not contribute to long-term stable operation. Another reason for the shutdown may be exceeding the rate of water injection into the rock [2].

Thus, with all the drawbacks, geothermal energy is a promising field of renewable energy, which is a worthy replacement for traditional energy sources.

**References:**


1. Salikeeva, S. N., Galeeva, F. T. *Obzor metodov polucheniya al'ternativnoj energii* [Overview of alternative energy production methods] // *Vestnik Kazanskogo tekhnologicheskogo universiteta* [Bulletin of the Kazan Technological University]. Kazan, 2012. Vol. 15, № 8. pp. 57-59 (in Russian).
2. *Geotermal'naya energetika: kak teplo Zemli prevratili v effektivnyj energoresurs Toshiba. 2015*. [Geothermal energy: how the Earth's heat was turned into an efficient energy resource. Toshiba. 2015]. URL: http://observatoria.rsl.ru/ru/s3/s17/s364/ok12015/ (date accessed: 28.04.2021).
3. Dvorov, I. M. *Geotermal'naya energetika* [Geothermal energy]. Moscow: Science, 1976. 192 p. (in Russian).
4. Alhasov, A. B. *Geotermal'naya energetika. Problemy, resursy, tekhnologi.* [Geothermal energy. Problems, resources, technologies]. Moscow: Physmathlith, 2008. 376 p. (in Russian).


**Список литературы:**


1. Саликеева С. Н., Галеева Ф. Т. Обзор методов получения альтернативной энергии // Вестник Казан. технол. ун-та. – 2012. – Т.15. – №8 – С. 57-59.
2. Геотермальная энергетика: как тепло Земли превратили в эффективный энергоресурс. Тошиба. – 2015. URL: http://observatoria.rsl.ru/ru/s3/s17/s364/ok12015/ (дата обращения: 28.04.2021).

3. Дворов И. М. Геотермальная энергетика. – Москва: Наука, 1976. – 192 с.
4. Алхасов А. Б. Геотермальная энергетика. Проблемы, ресурсы, технологии. – Москва: Физматлит, 2008. – 376 с.

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## CREATION OF WEB PAGES BY USING SITE DESIGNERS

**Abstract.** In this paper, we analyzed the approaches to developing web pages with the help of site designers. The advantages of constructors and the main reasons for their use by consumers are considered.

**Keywords:** web page, site, api, css, HTML.

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## СОЗДАНИЕ WEB-СТРАНИЦ ПРИ ПОМОЩИ КОНСТРУКТОРОВ САЙТОВ

**Аннотация.** В данной работе был произведен анализ подходов разработки веб-страниц с помощью конструкторов сайтов. Рассмотрены достоинства конструкторов, основные причины их использования потребителями.

**Ключевые слова:** веб-страница, сайт, api, css, HTML.

Website designers are services where anyone can create a fully functional website in just a couple of minutes – a business card, an online store, a blog, or something else. It is enough to register, choose a domain (site address) and customize the appearance of the site to suit your needs (look at the Figure 1). You can usually do this for free without spending a penny of your money [1]. Are there any prospects for designers to replace the mass manual layout, or are all these toys that have no prospects?

Let’s look at the main advantages of site designers:

1. No need to worry about hosting and domain – just register, and you can get started.

2. There are a large number of free site builders-available for any user.

3. Technical support will help you solve all the questions that the user may have.

4. As a rule, a decent appearance of the site.

However, why do the vast majority of those who want to create their own website turn to web studios or freelancers, spending impressive amounts?

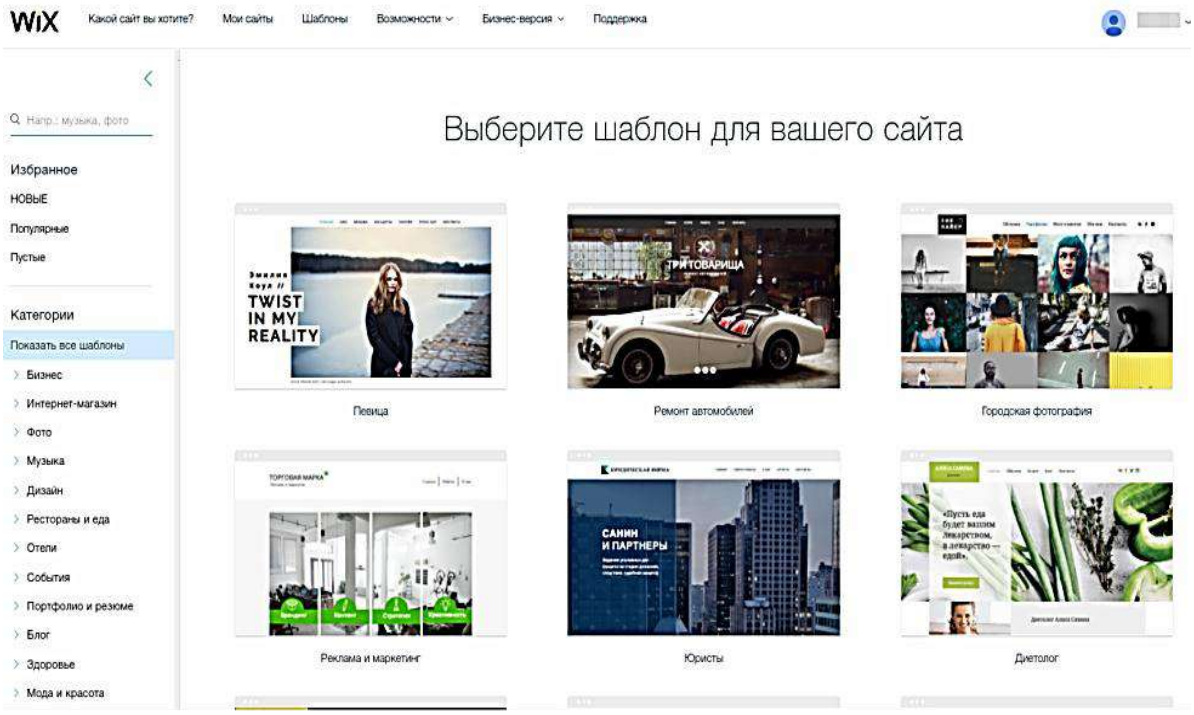


Fig. 1. Menu for choosing a templatefor creating your own website on a domain wix.com

This happens for the following reasons:

1. Free creation, it’s good. But you can only get a third-level domain for free. It will not be accepted in any money service – even in most teaser networks it will not get, so it is unlikely that you can get income from such a domain. You can usually connect a second-level domain that you bought separately to your site, but not always. And the service itself on a free site can turn its advertising, and to get rid of it – you need to pay. Only the basic set of features is provided free of charge. Everything else is paid. Even hosting, which is given for free, you do not own. Therefore, the administration of the service may, at its discretion, simply delete your site and explain nothing. And you will not be able to pick up the site and transfer it to another hosting, although some services provide this opportunity, but it is already paid.

2. The functionality of the sites in the constructor is very limited. There is a basic set of features, and you can’t add new plugins, scripts, or codes to the user. There is only the ability to change the labels and images. In some services, you can buy new features for a fee, but, again, from the standard set. It is not possible to develop the functionality as the user wants. You can’t even insert a banner in the wrong place.

3. High difficulty of promotion. Free hosting and third-level domains (and even second-level domains, but on free hosting) are always lowered in search results by

search engines. The advantage is given to sites with first-level domains located on fast, stable servers, for the use of which you need to pay. In addition, search engines lower the ranking of the output pages of the designers. This means that the constructor pages will be worse than the same pages written in a low-level web programming language. The design will not differ much from thousands of similar sites, although there is an external difference between them, but search engines see the same structure, which reduces the rating [2, 3].

4. The human factor – people who use site designers have little idea about sites in general, and about promotion and SEO – even more so. Therefore, they do not use even the modest features that the constructor gives them.

5. Extraneous advertising – the service spins its advertising on the user's site or inserts its logo or link in a prominent place. Disable this-for a fee, and the price per month can be as good as a decent paid hosting, or even more.

6. The constructor codes are open to everyone, and an attacker can find a way to harm the site in a way that is difficult or impossible to fix. The constructor is not protected from hacker attacks, especially those specialized to the code of this constructor. There are always vulnerabilities, and patches neutralize only those that are noticed, and the openness of the code always makes it possible to find a vulnerability.

7. Significantly longer generation and loading of pages created by designers. This means an unjustified load on the server and a large vulnerability with an increased number of accesses to the site.

Site designers have the right to exist. It all depends on the goals of the person who needs their own website. If a site is needed for a non-commercial activity, there are limited financial resources, and there are no required web programming skills – a site created by a designer will be the best choice. However, for something more, for example, to create a resource with the planned high traffic and to maintain it in a decent state, you need to develop a site from scratch, on your own or by contacting professionals.

**References:**


1. Babaev, A. M., Bode M. S., Evdokimov, N. V. (2014) *Sozdanie sajtov* [Creating of sites]. *Izdatel'stvo "Piter"*. 410 p. (in Russian).
2. Romanenkova, O. N. *SEO-prodvizhenie kak effektivnyj instrument internet – marketinga* [SEO promoting as an effective marketing tool]. // Strategii biznesa. 2014. №1 (3). URL: https://cyberleninka.ru/article/n/seo-prodvizhenie-ka.. (date accessed: 20.04. 2021).
3. Muradov, Alan. *HTML 5 dlya starshih razrabotchikov*. 2020. URL: https://libs.ru/book/915737/ (date accessed: 21.04. 2021).


**Список литературы:**


1. Бабаев А. М., Боде М. С., Евдокимов Н. В. Создание сайтов. – Издательство «Питер», 2014. – 410 с.
2. Романенкова О. Н. SEO-продвижение как эффективный инструмент интернет-маркетинга // Стратегии бизнеса. – 2014. – №1 (3).

URL: https://cyberleninka.ru/article/n/seo-prodvizhenie-ka.. (Дата обращения: 20.04. 2021).
3. Мурадов Алан. HTML 5 для старших разработчиков. – 2020. URL: https://libs.ru/book/915737/ (Дата обращения: 21.04. 2021).

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## ASSESSMENT OF PAPER AND CARDBOARD MICROSTRUCTURE BASED ON MODERN DIGITAL TECHNOLOGIES

**Abstract.** The work is dedicated to evaluating the microstructure of paper and paperboard using AutoCAD and lpSquare v5.0 for Windows programs. The ion beam cut method was adapted for the study of cardboard. Optimum cutting modes were established, namely time, thickness of cardboard, energy of a beam of argon ions. The summaries were processed by graphic and analytical programs. As a result, the property – the uniformity of fibre distribution in the cardboard is evaluated.

**Keywords:** microstructure, fibrous materials, cross section, ion beam.

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## ОЦЕНКА МИКРОСТРУКТУРЫ БУМАГИ И КАРТОНА НА БАЗЕ СОВРЕМЕННЫХ ЦИФРОВЫХ ТЕХНОЛОГИЙ

**Аннотация:** Работа посвящена оценке микроструктуры бумаги и картона с применением программ AutoCAD и lpSquare v5.0 for Windows. Кроме того, был адаптирован под исследование картона метод ионной резки. Установлены

оптимальные режимы резки, а именно: время, толщина картона, энергия пучка ионов аргона. Полученные срезы были обработаны графическими и аналитическими программами, в результате чего оценено свойство – равномерность распределения волокон в картоне.

**Ключевые слова**: микроструктура, волокнистые материалы, поперечный срез, ионная резка.

Fibrous material is the main raw material for the paper and cardboard production. The microstructure of fibres explains many physical phenomenon of fibrous material [1]. Ion beam cut, which has been adapted to produce a cross-section of two-layer fibrous material to electron microscopy, is a key tool for study. The ion beam cut of the samples was done by equipment of Technoorg Linda SEMPrep2 (model SC-2100, Hungary).

The two-layer fibrous material for the research was derived from the methodology presented in the papers [2, 3].

The selection of cutting modes was made according to the required quality of the cross section. Different options for cutting modes were considered (Figure 1).

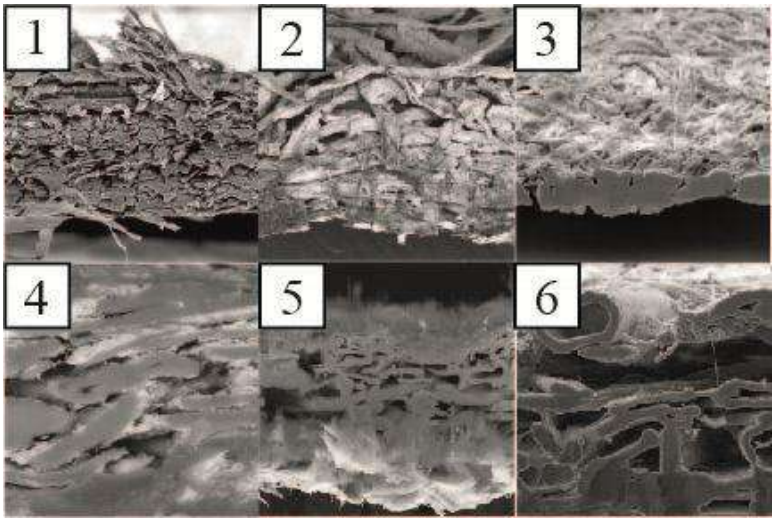


Figure 1. Cross-section of two-layer fibrous material: 1 – cut-off thickness -250 μm, cutting time – 5 minute, ion beam power – 0 keV; 2 – cut-off thickness -200 μm, cutting time – 40 minute, ion beam power – 15 keV; 3 – cut-off thickness -50 μm, cutting time – 40 minute, ion beam power – 12 keV; 4 – cut-off thickness -150 μm, cutting time – 40 minute, ion beam power – 8 keV; 5 – cut-off thickness -150 μm, cutting time – 1 hour, ion beam power – 8 keV; 6 – cut-off thickness -150 μm; cutting time – 2 hour; ion beam power – 8 keV

The required cross-section quality was obtained by increasing the cutting time to 2 hours.

The BSE Reflected Electron Detector (Back-Scattered Electron) was used to study the transverse cuts of the cardboard, as this visualizes the contrast in sample composition. Using an electron microscope, an image is created of the cross section of a fibrous sample (Figure 2, 1). The cut fibre area for each layer was defined by the

given shades. The cut of fibers area determine by the black color. The cut fiber regions are then separated and their area is located using the “Calculate” command (Figure 2, 2). The data for the area of regions 8 are counted according to the area of the figure with known dimensions (the proportion is calculated).

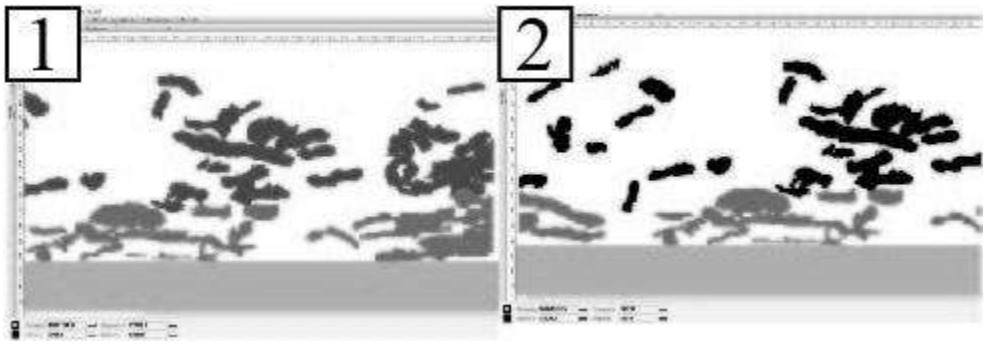


Figure 2. 1 – area of cut of fibers of two-layer material in program lProsoft; 2 – area calculation, “Calculate” command

AutoCAD has extensive capabilities in vector image processing and computation. Unlike the lProsoft AutoCAD program, it is possible to assess the uniformity of fiber distribution across the cross-section. For this purpose, the centers of the cutting areas are identified by the help of the “MAS-HAR” command. This command defines the coordinates of the point in the centre of the area of the fibre cut (Figure 3, 1). The coordinates of the points in the centre of the cut-off areas shall be joined by segments, and the segments shall not overlap (Figure 3, 1).


Figure 3. 1 – Determination of the centre of the cross-section of fibres:
– coordinates of the centre of the fibre area; 2 – Evaluation of the uniformity of the cross-section fibre distribution

The results of the graphical processing of the cross-sectional images of fibrous material are diagrams of the size distribution of the fibre area (Figure 4, a) and the uniformity of fibre distribution across the cross-section of cardboard (Figure 4, b).

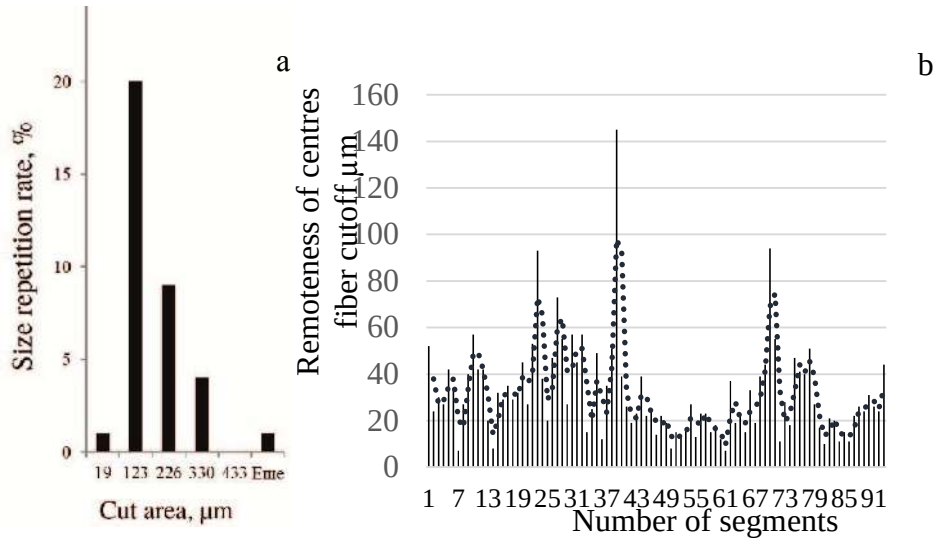


Figure 4. Size distribution of fibres (a) and uniformity of fibre distribution across the cross-section of cardboard (b)

Shows figure 4 b, the diagram showing the sections connecting the centres of the regions in cross-section of cardboard. Figure 4 b, measure the even distribution in three indicators: maximum deviation of centres from each other (145 microns); Number of sections (91 pieces at approximate thickness of transverse cut from 80 to 150 µm); by the average length of segments with the maximum value.

*Conclusions*

The ion cutting mode (thickness of 150 µm cut duration of 2 hours' power of ion beam 8 keV) is mounted, which makes it possible to obtain a qualitative image of the transverse cut of fibrous material. By help of lProsoft the area of fiber cut by a raster image is determined. AutoCAD has achieved precision in determining the area of fibre cut and has evaluated the uniformity of the area distribution of the cut.

Diagrams of the area distribution of the fibres and the uniformity of their distribution are obtained.

**References:**

1. SEMPrep2 High-quality site-specific sample preparation in SEM application. URL: http://www.technoorg.hu/static/downloads/semprep2cataloguepdf.pdf (date accessed: 17.04.2021)
2. Midukov, N. P. Proizvodstvo mnogoslojnogo kartona test-lajnera s belym sloem [Multilayer white-liner cardboard production]. SPb.: Printing Association of Higher Education Institutions. 2018. 208 p.
3. Midukov, N. P. Effect of virgin fiber content on strength and stiffness characteristics of a three-layer testliner/ N. P. Midukov, T. Schrinner, H. Grossmann, A. S. Smolin and V. S. Kurov // BioRes. 2015. Vol. 10(1), pp. 1747-1756.

**Список литературы:**
1. SEMPrep2 High-quality site-specific sample preparation in SEM application. URL: http://www.technoorg.hu/static/downloads/semprep2cataloguepdf.pdf (Дата обращения: 17.04.2021)
2. Мидуков, Н. П. Производство многослойного картона тест-лайнера с белым слоем. – СПб.: Полиграфическая ассоциация высших учебных заведений, 2018. – 208 с.
3. Midukov N. P. Effect of virgin fiber content on strength and stiffness characteristics of a three-layer testliner/ N.P. Midukov, T. Schrinner, H. Grossmann, A. S. Smolin and V. S. Kurov // BioRes. – 2015. – Vol. 10(1). – C.1747-1756.

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## FREQUENCY-CONTROLLED ELECTRIC DRIVE OF THE RECUPERATOR IN LIFTS

**Abstract.** A gearless elevator drive is used as an object of modernization. This article proposes to consider the prospect of supplementing the electric drive of elevators with recuperators. The benefits of supplementing the gearless elevator drive with a recuperator are substantiated.

**Keywords:** electricity saving, recuperator, gearless lift drive.

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## ЧАСТОТНО-РЕГУЛИРУЕМЫЙ ЭЛЕКТРОПРИВОД РЕКУПЕРАТОРА В ЛИФТАХ

**Аннотация.** В качестве объекта модернизации используется безредукторный привод лифта. В данной статье предлагается рассмотреть перспективу дополнения электропривода лифтов рекуператорами. Обосновывается выгода от дополнения схемы безредукторного привода лифта рекуператором.

**Ключевые слова:** экономия электричества, рекуператор, безредуктроный привод лифта.

In the modern world, humanity pays more and more attention to ecology, energy efficiency and energy conservation.

Energy conservation is a very important environmental challenge to conserve resources and reduce environmental pollution. The relevance of energy saving is growing in all countries, due to the outstripping rise in prices for the main traditional types of energy resources and the gradual depletion of their world reserves [1].

Saving electricity can be considered the most common. For a long time, manufacturers of various electrical equipment have been trying to increase energy efficiency. Most often, electricity is saved by replacing lighting elements, but this is far from the only way to save electricity. You can save energy consumption even with all the usual elevators.

Until recently, asynchronous machines with a relay-contactor control system and a phase rotor were used in elevator drive systems. But this is already an outdated technology, now there is an active introduction of frequency converters to regulate the speed of an electric motor and replace motors with a wound rotor with asynchronous ones with a squirrel-cage rotor [2].

The frequency converter provides contactless control of the asynchronous motor and smooth speed control, which greatly reduces the load on the mechanical part of the elevator. Such a replacement can also be made on elevators that have been in operation for a long time.

In elevator installations using a frequency converter, the best energy savings can be achieved by introducing a recuperator [3].

Recuperator – a device functioning in conjunction with a frequency converter, makes it possible during the operation of the converter to recuperate the energy released during braking. The recuperator is a separate device for the frequency converter.

Recuperators allow you to obtain economic benefits when used in drives of hoisting mechanisms, such as: cranes, lifts and similar systems. Recuperators are also used in modern trains and cars (when driving, the mechanism consumes energy from the network or the battery, and when braking, it returns electrical energy back to the power supply network) [4].

Until recently, braking resistors could have been a way to release the excess energy generated by a frequency converter during braking. These elements dissipate energy in the form of heat into the environment. They were used in electric drive complexes to eliminate overvoltage in frequency converters in the braking mode of systems with high inertial load. Installations without these resistors were not able to work, since due to their absence, a quick equipment failure is possible.

Braking resistors have many disadvantages. They have large overall dimensions, which in most cases is a huge disadvantage. They require the creation of certain conditions: good cooling, which requires additional huge space; protection against moisture and dust. To connect a braking resistor to a frequency converter, a special braking unit is required, which is again a financial cost.

The use of a recuperator in conjunction with a frequency converter can make it possible to use about 90 % of the electrical energy that is released during braking, and return it to the power supply network for the use of this energy by other consumers or again to the same device. From an economic point of view, this implementation will provide significant cost savings. The payback time for such a revision of the elevator device will be less than six months, taking into account all the costs of purchasing a recuperator and upgrading the elevator system [5].

Also, by modifying the lift with a recuperator, it will be possible to significantly reduce the level of harmonic distortion in the power supply network and significantly increase the power of the equipment used. The increase in capacity will provide a significant improvement in the energy efficiency of the entire complex, which will improve the characteristics of the supply network of the entire building.

In addition, important positive aspects of installing a recuperator in an elevator system include: compact size of equipment, there is no great need for moisture and dust insulation; an increase in the braking torque and a decrease in the braking time of the electric drive; the ability to communicate with the recuperator via industrial networks; great flexibility in the use of recuperators for various applications; the ability to connect several recuperators in parallel.

Thus, the recuperator is an excellent alternative to braking resistors in many respects, and moreover, it has many more technological and economic advantages.

So, it becomes obvious that energy saving can be done with the help of many devices, even such ones as familiar to us as an elevator. The introduction of innovative energy-saving measures, such as the use of modern frequency converters together with energy recuperators on devices with an asynchronous electric motor, will save about 30 % of energy resources, while the costs of purchasing and installing this equipment can be recouped in less than six months.

**References:**


1. Omelchenko, D. P. *Energosberezhenie i puti optimizatzii ispol'zovaniya elektricheskoy energii* [Energy saving and ways to optimize the use of electric energy] // *Sovremennye problem nauki I obrazovanya* [Modern problems of science and education]. 2014. URL: https://science-education.ru/ru/article/view?id=15936 (date accessed: 01.03.2021).
2. Umanskaya, M. Z., Rapoport, Z. G., Afonin, A. K. *Sposob rekuperatzii energii dvizheniya lifta* [A method for recovering the energy of the elevator movement]. URL: https://findpatent.ru/patent/258/2588923.html (date accessed: 03.02.2021).
3. Sat, M. M. *Ispol'zovanie energii rekuperatzii dlya snizheniya elektropotreblenya liftovym oborudovaniem* [Use of energy recovery to reduce the power consumption of elevator equipment] // *Molodoy uchenyy* [Young scientist]. 2019. URL: https://moluch.ru/archive/247/56913/ (date accessed: 01.03.2021).
4. *Naznachenye rekuperatorov* [Purpose of recuperators]. URL: https://rusautomation.ru/privodnaya-tehnika/rekuperatory (date accessed: 11.03.2021).

5. *Rekuperativnoe tormozhenie* [Regenerative braking]. URL: https://amperof.ru/teoriya/rekuperaciya-elektroenergii.html (date accessed: 12.03.2021).

**Список литературы:**

1. Омельченко Д. П. Энергосбережение и пути оптимизации использования электрической энергии. Современные проблемы науки и образования. – 2014. – №6. URL: https://science-education.ru/ru/article/view?id=15936 (дата обращения: 01.03.2021).
2. Уманская М. З., Рапопорт З. Г., Афонин А. К. Способ рекуперации энергии движения лифта. URL: https://findpatent.ru/patent/258/2588923.html (дата обращения: 02.03.2021).
3. Сат М. М. Использование энергии рекуперации для снижения электропотребления лифтовым оборудованием. Молодой учёный. – 2019. – №9. URL: https://moluch.ru/archive/247/56913/ (дата обращения: 01.03.2021).
4. Назначение рекуператоров. URL: https://rusautomation.ru/privodnaya-tehnika/rekuperatory (дата обращения: 11.03.2021).
5. Рекуперативное торможение. URL: https://amperof.ru/teoriya/rekuperaciya-elektroenergii.html (дата обращения: 12.03.2021).

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## QUASICRYSTALS: PRODUCTION, PROPERTIES, PROSPECT FOR USE

**Abstract.** The article considers production of quasicrystals, their properties, as well as their difference from ordinary crystals. Prospects for the practical application of quasicrystals in the household are described.

**Keywords:** crystals, quasicrystals, icosahedral structure, long range order, aggregate states of matter.

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# КВАЗИКРИСТАЛЛЫ: ПОЛУЧЕНИЕ, СВОЙСТВА, ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ

**Аннотация.** Данная статья рассматривает получение квазикристаллов, их свойства, а также их отличие от обычных кристаллов. Описываются перспективы практического применения квазикристаллов в домашнем хозяйстве.

**Ключевые слова:** кристаллы, квазикристаллы, икосаэдрическая структура, дальний порядок, агрегатное состояние веществ.

All substances in nature have a certain aggregate state, there are:

1. Gaseous, liquid or solid (crystalline) states.
2. Amorphous or glassy state, which has signs of both liquid and solid matter.
3. Plasma is a state that occurs at a very high temperature (in some ways it is similar to a gas, but in its hot mixture, in addition to atoms, there are charged particles – electrons and ions).

Aggregate states of matter (from the Latin aggrego – to attach, bind) are states of the same substance, transitions between which correspond to abrupt changes in free energy, entropy, density and other physical parameters of the substance [1; 5].

The transitions that occur during pressure and temperature changes between aggregate states are presented in Fig. 1.

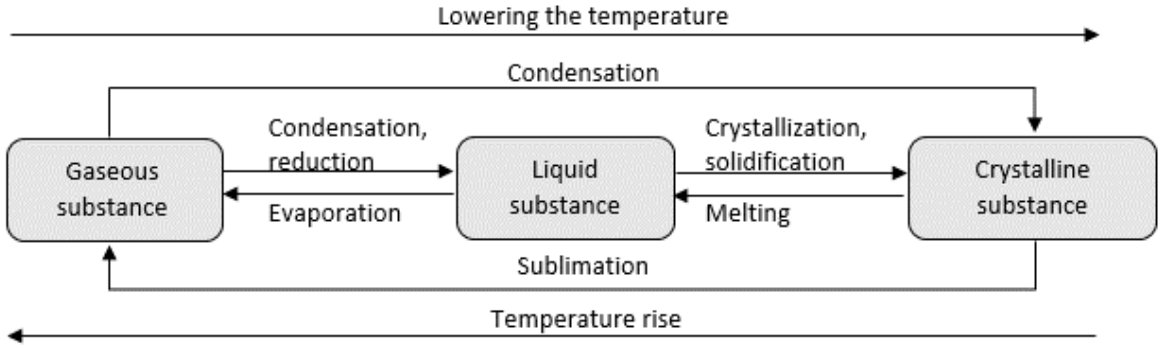



Fig. 1. The transitions that occur during pressure and temperature changes between aggregate states

The transition from the crystalline state to the liquid state is characterized by the melting point, and the reverse transition is characterized by the solidification temperature. This is the same temperature when equilibration is established between

the liquid and the crystalline substance. This temperature is not dependent very much [2; 175].

The structure of crystalline substances is similar to solid ones. In crystals, material particles, for example, molecules, are oriented relative to each other. As a result, the crystal takes a certain shape in the form of some kind of polyhedron.

Material particles perform thermal vibrations around equilibrium positions. If the temperature is the far from the melting point of the crystal, particles almost never move steadily as a rule [3; 7]. This is the main difference between crystals and liquids.

About half a million crystal structures have been deciphered to date. This is the richest heritage of the last century was the result of the era of X-ray crystallography, or crystal chemistry, and allowed the United Nations to call the year 2014 the "Year of Crystal Chemistry".

Most of the substances that we meet in our life are crystals.

If we know the crystal structure of a chemical compound, we can estimate its melting point, thermal expansion, compressibility, optical properties, solubility, etc. This structure has quite predictive properties.

The discovery of quasicrystals with an icosahedral structure in 1984 (alloy of aluminum with manganese Al0.86 Mn0.14 was detected, a sample of which, subjected to a special method of rapid cooling, scattered an electron beam so that a pronounced diffraction pattern with a fifth-order symmetry was formed on the photographic plate in location of diffraction maxima) refutes some well-established scientific theories and views concerning the synthesis of new materials. A quasicrystal is a highly organized solid phase, radically different in its properties from crystals, glasses and everything that was known before. The extraordinary properties of quasicrystals, their high mechanical strength are explained by the lack of periodicity of the structure, which leads to a slowdown in the propagation of dislocations in comparison with ordinary crystalline materials. Due to their unique combinations of physical properties, quasicrystals are promising materials for aerospace, rocket, instrument-making, and energy industries. They are applied most constructively in the form of nano-objects – as coatings, fillers, ultrafine when creating composite materials and ultrafine modifiers [4; 80].

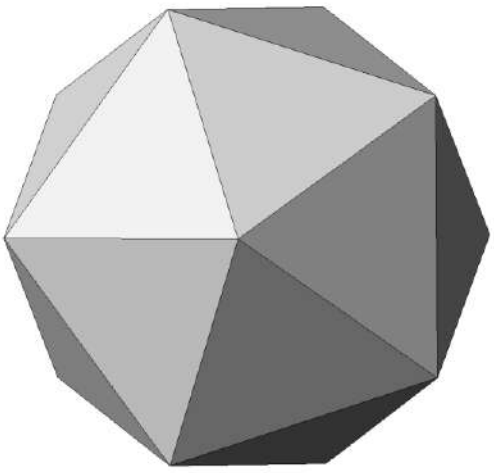
Atomic structure of quasicrystals is a most important problem in the physics.

We can understand their structure using the mathematical theory of tiling. (Tiling is covering an entire plane or filling an entire space with non-overlapping shapes).

An ordinary crystal is a periodic structure of atoms or molecules. A certain symmetry is inherent in any crystal structure. Crystals have two types of long-range order, orientation and translational. Translational order means the ability to construct a crystal structure by translating an elementary building block of a structure with a specific arrangement of atoms to a certain vector of the crystal unit cell. In this case, one speaks of the existence of long-range order in the crystal. Orientation order means that the rotation of the crystal about a certain axis aligns the atomic positions with themselves. Crystals can have rotational symmetry of the third, fourth, or sixth order. For example, if a crystal has a third-order symmetry axis, its crystal lattice will not change after rotation by one third of the circle. The structure of the unit cell of most

crystals is based on such simple geometric bodies as a cube, tetrahedron, and octahedron.

The structure of quasicrystals, such as an aluminum-manganese alloy, is based on another geometric solid which is called an icosahedron. Icosahedron is a polyhedron



with 20 faces, each of which is an equilateral triangle, 12 vertices and 30 edges (Fig. 2). The icosahedron has a fifth-order symmetry: at each of its vertices, five faces are connected. The geometry of the icosahedron occupies an important place in many areas of mathematical analysis, such as the problem of solving equations of the fifth degree, group theory, and chaos theory.

Icosahedron cannot be packed so that they fill the entire space tightly, without gaps that is why they cannot be used as the elementary cells of crystals [5; 87].

So, the properties of quasicrystals include a low coefficient of friction and low wettability, high hardness, wear resistance and corrosion resistance, significant radiation resistance of the structure, low electrical and thermal conductivity, and unusual optical properties. But the possibilities of use are limited due to high brittleness and low deformability at low temperatures.

These properties make it possible to use quasicrystals as coatings for pans, as a work surface for cooking. The coating based on the icosahedral Al-Cu-Fe phase is universal for roasting meat. They do not emit toxic gaseous products when overheated, unlike Teflon coatings.

There is a possibility of using quasicrystals in selective absorbers of solar energy, namely to convert solar radiation into heat. Selective absorbers are used to heat water to temperatures of 400 °C and 60 °C respectively in heat generators of electrical energy and in domestic water heaters. An ideal selective solar absorber should have a high absorption in the visible spectrum and at the same time a high reflectivity in the infrared range in order to minimize thermal radiation losses. One of the best absorbers is tungsten.

Quasicrystals can be used as thermoelectric converters for use in solid-state refrigerators and electrical power generators. Quasicrystals have low electrical conductivity, which, as a rule, grows with increasing temperature and changes greatly even with an insignificant chemical composition; the Seebeck and Hall coefficients show the same sensitivity to the composition. Their important advantage is that their lattice thermal conductivity is extremely low and close in magnitude to the thermal

conductivity of dielectric glasses. The features of the electronic structure of quasicrystals make it possible to reach the limit of the efficiency parameter of the thermoelectric converter equal to one and significantly exceed it.

Metal hydride hydrogen storage systems are the most actively developing areas of hydrogen energy. Among the quasicrystalline phases, the icosaeric phase in the Ti-Zr-Ni ternary system, which is capable of absorbing almost two hydrogen atoms per metal atom, turned out to be a promising hydrogen storage medium. This phase quickly absorbs and releases hydrogen better than intermetallic compounds such as $LaNi_5$. Hydrogen can accumulate in an almost atomic form, and this is a significant advantage over hydrides, where hydrogen is in a bound form.

Quasicrystalline "structures" created by molecular beam deposition and lithography (Fibonacci superlattices used in laser technology to generate higher harmonics, photonic quasicrystals with octagonal and pentagonal symmetry, possessing an isotropic band gap) are widely used.

Quasicrystals and materials based on them have great potential for industrial applications. The technologies developed today for obtaining coatings from quasicrystals, as well as multiphase and composite materials based on them, have made it possible to completely eliminate the limitations associated with the brittleness of quasicrystalline phases and their low deformability at room temperature. Quasicrystals have already found wide application as a hardening phase in high-strength maraging steel, from which surgical instruments are made, and in extra-strong aluminum alloys.

The prospects for the use of quasicrystals have not been fully studied, but we can already notice their extensive use in the household and more. Therefore, in the coming years, significant progress in the field of the industrial and in the household applications of quasicrystalline materials should be expected.

**References:**


1. Bogoslovsky, S. V. *Fizicheskie svojstva gazov i zhidkostej* [Physical properties of gases and liquids]. St. Petersburg: SPbSUAI, 2001. 73 p. (in Russian).
2. Glinka, N. L. *Obshchaya himiya* [General chemistry]. Moscow. Uchebnik, 2012. 175 p. (in Russian).
3. Bokiy, G. B. *Kristallohimiya* [Crystal chemistry]. Moscow. Kniga, 1971. 400 p. (in Russian).
4. Saunin, V. N., Telegin, S. V., Kovalkova, V. P. *Kvazikristally, perspektivy primeneniya, sposob polucheniya* [Quasicrystals, application prospects, production method]. // Vestnik Sibirskogo gosudarstvennogo aerokosmicheskogo universiteta im. academician M. F. Reshetnev [Bulletin of the Siberian State Aerospace University named after academician M. F. Reshetnev]. 2009. Vol. 1-2, № 22, pp. 80-83 (in Russian).
5. Vekilov, Yu. Kh. *Fizika* [Physics] *Chto takoe kvazikristally* [What are quasicrystals] // Obrazovatel'nyj zhurnal Sorosa [Soros Educational Journal]. 1997. Vol. 3, № 1, pp. 87-91 (in Russian).

**Список литературы:**
1. Богословский С. В. Физические свойства газов и жидкостей. – СПб.: СПбГУАП, 2001. – 73 с.
2. Глинка Н. Л. Общая химия. – М.: Учебник, 2012. – 175 с.
3. Бокий Г. Б. Кристаллохимия. – М.: Книга, 1971. – 400 с.
4. Саунин В. Н., Телегин С. В., Ковалькова В. П. Квазикристаллы, перспективы применения, способ получения // Вестник Сибирского государственного аэрокосмического университета им. академик М. Ф. Решетнев. – 2009. – Т. 1-2. – №22. – С. 80-83.
5. Векилов Ю. Х. Физика // Что такое квазикристаллы // Образовательный журнал Сороса. – 1997. – Т. 3. – №1. – С. 87-91.

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## PLANT CATALOGUE AS AN EDUCATIONAL RESOURCE

**Abstract.** The article presents the project on drawing up a catalogue of plants growing in St. Petersburg Forest Technical university park. The history and botanical description of the most valuable tree and plant species illustrated by students' photographs and drawings is to be used as an educational resource as well as the university park image creating instrument.

**Keywords:** plant catalogue, university park, St. Petersburg State Forest Technical university, botanical illustrations.

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# КАТАЛОГ РАСТЕНИЙ КАК ОБРАЗОВАТЕЛЬНЫЙ РЕСУРС

**Аннотация.** В статье представлен проект составления каталога растений, произрастающих в парке Санкт-Петербургского лесотехнического университета. Предполагается использование каталога, иллюстрированного фотографиями и рисунками студентов, с описанием истории и ботанических особенностей наиболее ценных видов растений и деревьев в качестве образовательного ресурса и инструмента создания имиджа парка университета.

**Ключевые слова**: каталог растений, парк университета, Санкт-Петербургский государственный лесотехнический университет, ботанические иллюстрации.

The first plant catalogues date back to the beginning of the 17th century. The oldest surviving European catalogue was compiled by Emmanuel Sweerts in 1612 [1]. He was a Dutch merchant and sold bulbs and plants. The aim of this catalogue compiling as well as the aim of compiling of the second oldest catalogue published by Crispijn van de Passe in1614 was to show the customers what the plants would look like in bloom. Since then a huge number of catalogues have been published and the main idea has always been to describe, make up an inventory and present plants growing in a certain place or being sold. Many scientific articles analyse the principles of plant catalogue compiling [2, 3, 4].

Against the long list of different catalogues those made on the basis of university parks stand out for several reasons:

1. Besides making an inventory of plants growing on the territory of a university park, these catalogues are usually considered to be an educational resource.
2. University park plants catalogue compiling is a scientific work – very time and efforts consuming and, at the same time, very creative.
3. Such work links students participating in it with the university and helps them to feel themselves true researchers.
4. The catalogue compiling is a very good tool for the university image creating.
5. To make a catalogue the efforts of different specialists and students from different specialties are needed which helps to develop such skills as team work, data collecting and analyzing.

This year a decision was taken to start a students' pilot project of university plants catalogue compiling. The aim of the work was threefold: to make catalogue of the most valuable plants growing in the university park with their botanical

illustrations, description in the Russian and the English languages; to find and include in the catalogue the historical and landscape architecture objects located on the university park territory; to make the catalogue an image creating instrument to promote the university both in Russia and abroad.

For the pilot project 20 tree and shrub species were chosen. They are those plants which are considered to be the most valuable for the dendrological garden of the university – old-aged plants, for example, pendunculate oak (Quercus robur) planted when the university was being organized and its buildings constructed; Albanian forsythia (Forsythia europaea) which starts blooming the first in the university park; common/European larch (Larix deciclua) planted in the park in 1820s; Amur corktree (Phellodendron amurense) – endemic species of the Far East (endemic means species growing on restricted areas and introduced into the flora of different areas); common/European yew (Taxus baccata); Chinese white pine (Pinus koreensis).

For all of the plants there were made up short historical, biological and ecological descriptions and the description of the plants' morphological characteristics. For each plant botanical illustrations were also drawn. Botanical illustrations are not just beautiful drawings – first of all, they are the illustration of scientific description of a plant. Therefore they should be precise in every detail. Another very important thing about botanical illustrations is that they have tremendous historical background: the first documented botanical illustrations date back to as early as the year 512. Since then the manner of plants depicting has not changed which means a special responsibility resting with the author. Each illustration drawing of the university catalogue took about two days. An example of botanical illustration is shown in the Fig. 1.


Fig. 1. Amur corktree (Phellodendron amurense) growing in the university park

Among the historical and landscape architecture objects the most interesting are an obelisk on the place of Novoseltsev and Chernov duel, the wooden vase in front of the main entrance of the university, the alley named after Kaigorodov, his burial place and others. All in all there are 17 monuments of Federal significance (23 objects) and 8 monuments of regional significance.

Conclusions: university park plants catalogue compiled in the framework of the pilot project is the first stage of larger work on creating full scale university park description. The work is to involve students of at least 4 specialties: forestry, landscape architecture, design and information technologies – in case if virtual catalogue is made.

**References:**


1. Sweerts, E. (1976) Early Floral Engravings: All 110 Plates from the 1612 Florilegium. New York: Dover. 128 p.
2. Pahomov, A. N., Sulimova, S. V. *Principi razrabotki katalogov-spravochnikov*. [Principles of catalogues-reference books elaboration] // *Mezhdunarodniy nauchniy jurnal "Simvol Nauki"* [International scientific journal "Simbol of Science"]. 2016. N 3, pp. 138-140. (in Russian)
3. Antonova, S. G. *Redaktorskaya podgotovka izdaniy: uchebnoye posobiye.* [Editorial publications preparation: textbook]. Moscow: MSUTU publishing house, 2002. 468 p. (in Russian)
4. Krupina, N. I., Prisiazhnaya, A. A., Titova, N. F. *Sozdanie katalogov – sistemniy podhod k formirovaniyu i izucheniyu nauchnih kollektziy* [Catalogues creation – systematic approach to scientific collections formation and study]. *Zhizn Zemli* [The Earth Life]. 2012. Vol. 34, pp. 257-260. (in Russian)


**Список литературы:**


1. Sweerts E. Early Floral Engravings: All 110 Plates from the 1612 Florilegium. New York: Dover, 1976. – 128 с.
2. Пахомов А. Н., Сулимова С. В. Принципы разработки каталогов-справочников // Международный научный журнал «Символ науки». – 2016. – №3. – С. 138-140.
3. Антонова С. Г. Редакторская подготовка изданий. – М.: Издательство МГУП, 2002. – 468 с.
4. Крупина Н. И., Присяжная А. А., Титова Н. Ф. Создание каталогов – системный подход к формированию и изучению научных коллекций // Жизнь Земли. – 2012. – Т. 34. – С. 257-260.

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## THE IMPACT OF NITROGEN DIOXIDE ON HUMAN LIFE

**Abstract.** Nitrogen dioxide is a gas that is heavier than air. It belongs to the hazard class 3. The study of the impact of this poisonous gas on human life and the life of other organisms is presented in this article.

**Keywords:** nitrogen dioxide, hazard class, air, poisonous gas.

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## ВЛИЯНИЕ ДИОКСИДА АЗОТА НА ЖИЗНЬ ЧЕЛОВЕКА

**Аннотация.** Диоксид азота – газ, который тяжелее воздуха. Его относят к третьему классу опасности. В данной статье представлено исследование влияния этого ядовитого газа на жизнь людей и жизнь других организмов.

**Ключевые слова**: диоксид азота, класс опасности, воздух, ядовитый газ.

Every day many harmful gases enter the atmosphere of our planet, affecting not only human life, but also the entire planet. One of these substances is nitrogen dioxide.

Nitrogen dioxide is a brown gas with a molar mass of 46.0055 g/mol, which means that it is heavier than air (the molar mass of air is 28.98 g/mol). It is a poisonous gas or, depending on conditions, a liquid. Also, NO2 is an organic compound of oxygen and nitrogen.

It can be produced in several ways:

1. Interaction of metals after hydrogen with nitric acid (e.g., copper):

*Cu + 4HNO3 = Cu (NO3)2 + 2NO2 + 2H2O.*

2. Reaction of nitrite with sulphuric acid:

*2NaNO2 + H2SO4 = Na2SO4 + NO2 + NO + H2O.*

3. Oxidation of nitrogen oxides with lower oxidation states:

*2NO + O2 = 2NO2.*

4. Decomposition of nitrates of metals which are more to the right of magnesium in the series of electrochemical activity (the most commonly used method in industry):

*2AgNO3 = 2Ag + 2NO2 + O2.*

As mentioned above, NO2 is a poisonous gas. It is classified as Hazard Class 3. This means that their lethal dose is 501-2500 mg/kg for skin contact and 151-5000 mg/kg for stomach contact.

Like any hazardous substance, nitrogen dioxide has its own MAC. The MAC is the maximum allowable concentration of a substance that is not detrimental to human life and performance, and does not adversely affect future generations. For nitrogen dioxide, the MACad (maximum allowable average daily concentration of a chemical substance in the air of populated areas) is applicable. This concentration must not have any direct or indirect harmful effect on humans through indefinite inhalation. MACad (NO2) = 0.1 mg/m3 [1].

The World Health Organization has established that average nitrogen dioxide concentration of 400 μg/m3 per hour identifies symptoms in asthmatics and hypersensitive groups. At an average nitrogen dioxide concentration of 30 μg/m3 per year, the number of children with rapid breathing, coughing and bronchitis increases. At high concentrations of nitrogen oxides (0.004-0.008 %), asthmatic manifestations and pulmonary oedema occur. Nitrogen dioxide is dangerous because, when inhaling the air, a person has no discomfort and no adverse effects are anticipated.

The mechanism of human exposure to nitrogen oxide is that dissolution occurs inside the lungs, so nitrogen dioxide has an adverse effect on the mucous membranes of the respiratory system and can cause burns. Symptoms include eye irritation, impaired sense of smell, dry and stuffy throat, inflammation of the gastrointestinal mucosa, cardiac weakness, and nervous disorders. Nitrogen dioxide reduces the body's resistance to disease, irritates the respiratory tract, causes respiratory and circulatory diseases, and can provoke malignant tumours. It also lowers haemoglobin levels, so prolonged inhalation of this gas causes oxygen deprivation in tissues. Long-term exposure will result in symptoms such as acute respiratory tract infections, pneumonia, bronchitis. A secondary reaction to exposure to nitrogen oxides is the formation of nitrites in the human body and their absorption into the blood. This causes transformation of haemoglobin into metahaemoglobin, resulting in impaired cardiac function.

It should also be mentioned that nitrogen dioxide causes acid rain at high concentrations in the atmosphere. Of course, they will not cause great harm to human health, but their excess has an adverse effect on the flora that surrounds us.

The reactions of this substance make it clear that NO2 doesn't just occur in amounts that are dangerous to humans. Consider the causes of atmospheric pollution by nitrogen dioxide:

1. High traffic intensity.

2. Difficulty of mass transfer and dilution of impurities inside the street canyon formed inside the buildings densely adjacent to each other (in St. Petersburg it is especially important near the avenues – Nevsky, Ligovsky, Moskovsky, Liteiny, etc.) [2].

3. Unfavorable meteorological conditions (a set of meteorological conditions causing deteriorated dispersion of pollutants in the atmosphere and contributing to their accumulation in the surface layer of the atmosphere; these include windless weather, temperature inversion).

4. High NOx to NO2 conversion factor.

5. Large number of energy facilities (characteristic of large cities, which includes St. Petersburg).

6. High-rise development is also a factor that results in pollution of the atmosphere with nitrogen oxide IV due to too high concentration of emissions.

7. Waste incinerators, metal smelters also emit quantities of NO2 which can exceed the MAC. Such emissions are called “fox-tail” because of their color.

The consequences of excess nitrogen dioxide in the atmosphere can be catastrophic for humans, so methods are used to neutralize it:

1. Adsorption methods. Activated carbon and silica gel serve as sorbents, but each has disadvantages. The first one oxidizes, which leads to its combustion, the second one is less effective, but is more durable and not subject to oxidation.

2. Catalytic reduction. The reducing agents are hydrogen or natural gas. The catalysts are elements of platinum group. This process is only possible at high temperatures (from 400 °C to 800 °C).

3. Urea method. Quite effective, as it can clean flue gases from nitrogen oxides by about 95 %. Also, this process is preferable as it produces non-toxic, or low-toxic substances such as N2, H2O, CO2.

4. Controlled combustion. This method involves combustion with low concentrations of air and the use of burners to reduce the yield of NO2.

5. Stimulation of chemical reactions by means of an electron beam. The method allows the reduction of nitrogen dioxide in a reaction with ammonia without the use of a catalyst. The product of the chemical reaction will be a mixture of inorganic salts – ammonium sulphate and ammonium nitrate. Through this process, approximately 85% of the nitrogen dioxide is recovered [3; 324].

Despite the significant harm caused by NO2 to the human body, it is used in industry:

1. Obtaining nitric acid. Nitric acid is one of the strongest solvents and in any concentration exhibits the properties of an oxidizing acid. It is used in the production of mineral fertilizers, jewelry making, machine drawing, military industry, etc.

The method is a catalytic oxidation of synthetic ammonia to a mixture of nitrogen oxides, which are subsequently absorbed by water.

*4NO2 + O2 + 2H2O = 4HNO3*

2. Production of sulphuric acid. Other strong acids can be obtained using nitrogen dioxide. Sulphuric acid has found application in ore processing as an electrolyte and in production of mineral fertilizers.

The nitrous method is oxidation of sulphur dioxide to sulphuric acid in a special tower.

*SO2 + NO2 + H2O = H2SO4 + NO*

Also, nitrogen oxide IV can be used as an oxidizer in rocket fuel and in mixed explosives [4].

In conclusion, it should be noted that despite the enormous industrial importance of nitrogen dioxide, it is important to understand that it is a very hazardous substance that can cause irreparable harm to human life and health.

**References:**


1. Rudakov, D. A. (2018) A New Method of Nitrogen Dioxide Production. URL: https://www.researchgate.net/publication/325846942 (date accessed: 03.04.2021).
2. Lozhkina, O. V., Marchenko, V. S., Sorokina, O. V. *Postanovka i rezul'taty chislennykh issledovaniy vozniknoveniya chrezvychaynogo lokal'nogo zagryazneniya vozdukha $NO_x$ vblizi avtodorog na primere Sankt-Peterburga* [Formulation and results of numerical studies of the occurrence of extreme local NOx air pollution near highways on the example of St. Petersburg]. URL: https://cyberleninka.ru/article/n/postanovka-i-rezultaty-chislennyh-issledovaniy-vozniknoveniya-chrezvychaynogo-lokalnogo-zagryazneniya-vozduha-no-h-vblizi-avtodorog-na/viewer (date accessed: 06.04.2021).
3. Anikin, V. A. *Sovremennye metody ochistki otkhodyashchikh gazov* [Modern waste gas cleaning methods]. *Sovremennye naukoemkie tekhnologii* [Modern knowledge-intensive technologies]. 2013. № 8-2. 324 p. (in Russian).
4. Lozhkin, V. N., Luk'yanov, S. V., Lozhkina, O. V. *Eksperimental'no analiticheskoe issledovanie zagryazneniya atmosfery vblizi KAD Sankt-Peterburga*. URL: https://cyberleninka.ru/article/n/eksperimentalno-analiticheskoe-issledovanie-zagryazneniya-atmosfery-vblizi-kad-sankt-peterburga/viewer (date accessed: 20.04.2021).


**Список литературы:**


1. Rudakov D. A. A New Method of Nitrogen Dioxide Production. – 2018. URL: https://www.researchgate.net/publication/325846942 (дата обращения: 03.04.2021).
2. Ложкина О. В., Марченко В. С., Сорокина О. В. Постановка и результаты численных исследований возникновения чрезвычайного локального загрязнения воздуха $NO_x$ вблизи автодорог на примере Санкт-Петербурга. URL: https://cyberleninka.ru/article/n/postanovka-i-rezultaty-chislennyh-issledovaniy-vozniknoveniya-chrezvychaynogo-lokalnogo-zagryazneniya-vozduha-no-h-vblizi-avtodorog-na/viewer (дата обращения: 06.04.2021).
3. Аникин В. А. Современные методы очистки отходящих газов // Современные наукоемкие технологии. – 2013. – № 8-2. – 324 с.
4. Ложкин В. Н., Лукьянов С. В., Ложкина О. В. Экспериментально аналитическое исследование загрязнения атмосферы вблизи КАД Санкт-Петербурга. URL: https://cyberleninka.ru/article/n/postanovka-i-rezultaty-chislennyh-issledovaniy-vozniknoveniya-chrezvychaynogo-lokalnogo-zagryazneniya-vozduha-no-h-vblizi-avtodorog-na/viewer (дата обращения: 20.04.2021).

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# APPLICATION OF AR AND QR CODE TECHNOLOGY IN THE EDUCATIONAL PROCESS

**Abstract**. The article examines the possibilities of using QR codes and augmented reality (AR) in the educational process. On the basis of stereometric data the website has been created that uses augmented reality based on reading QR codes. The author concludes that QR and AR technologies provides the latest technologies, a unique complex interactive experience, thereby improving the educational process.

**Keywords**: QR technology, augmented reality, 3D model, interactivity, virtual space.

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# ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ AR И ТЕХНОЛОГИИ QR-КОДОВ В ОБРАЗОВАТЕЛЬНОМ ПРОЦЕССЕ

**Аннотация**. В статье исследуются возможности использования QR-кодов и дополненной реальности (AR) в учебном процессе. На основе стереометрических данных создан сайт, использующий дополненную реальность на основе считывания QR-кодов. Автор приходит к выводу, что технологии QR и AR предоставляют новейшие технологии, уникальный комплексный интерактивный опыт, тем самым улучшая учебный процесс.

**Ключевые слова**: технология QR, дополненная реальность, 3D модель, интерактивность, виртуальное пространство.

Augmented Reality (AR) is a kind of virtual environment (VE) that complements the physical world in a real time by means of devices that have the ability to generate virtual objects using data from the real world. Such devices are tablets, smartphones and others. AR technology unlike virtual reality does not immerse a person in the created world with the help of its senses but complements reality by projecting objects onto the real environment [1].

Augmented reality has three characteristics:

- it combines real and virtual worlds;
- it has an interactive nature of the activity in real time;
- it includes 3D modelling of space.

*The main purpose of using augmented reality in the modern educational process* is to add variety to the studies of material, to attract attention and increase the motivation of students. Augmented reality is especially useful in those disciplines that require real-time visual presentation of material. Due to the fact that the space is three-dimensional and has the ability to interact between real and virtual worlds, it is possible to more clearly observe the connections and contacts of various elements for educational purposes. The educational environment is actively introducing various new information technologies and high-performance equipment, which in turn may lead to the fact that augmented reality will become a key element [2]. Some tasks for constructing sections or slices are quite complex, and the visualization of these tasks becomes problematic, when using augmented reality, this problem will be solved. Augmented reality can help learners gain rich interactive experiences and help teachers and educators meet curriculum and institutional requirements. Such technologies will help students to better represent the object under study, improve spatial thinking and diversify the educational process.

*Creation of a website using augmented reality.* Based on the knowledge of the HTML language and the AR.js library (AR.js is a library for creating augmented reality which is combined with the A-Frame framework and designed for developing VR on the Internet [3]) a website has been created. To create a website 3D models and QR codes are required which will be linked between each other. The site asks for permission to use the camera when hovering over the QR code, and shows the corresponding 3D model. The user is able to move the camera at different angles and see the figure from different sides accordingly, since the QR code is a marker, positioning is based on its reading, surface recognition and gyroscope sensor. It is worth mentioning that this technology only works on modern devices.

3D models are developed in the Autodesk 3DS Max program (Autodesk 3dsMax is a professional software for 3D modeling, animation and visualization when creating games and designing), they are recorded in a special glTF format, as soon as this format is supported by our site. The GL Transmission Format (glTF) is a format for efficiently transferring and loading 3D scenes and models. It minimizes both the size of the 3D resources and the runtime handling required to unpack and use the model. There is also a binary version of glTF called GLB, the difference of which is that the structure written in the JSON standard and the binary file is stored in one file with the GLB extension [4]. This format is more convenient, which is why it will be used. The site will work on the basis of educational material from manuals on stereometry [5]. It is in the study of stereometry, as the science of volumetric bodies, that the need arises for the implementation of AR technology. The site will reflect various shapes in space: a ball, cube, cone, cylinder, etc.

If necessary, it is possible in the future to easily implement that when you point the camera at the QR code, 2D images, GIF, 3D model, video are displayed. It is also possible to add animation tools, particulate to animate the scene, this can be achieved using Unity. Unity is a modern cross-platform game and application development

engine developed by Unity Technologies. The glTF format allows you to store not only the model, but also the scene, that is, when you hover the camera over the marker, not just the model can be reflected, but the model in motion, or even several models interacting with each other. The potential of augmented reality is huge, and there are many ways to implement it.

Thus, it becomes possible to consider each of the figures, as well as cuts and sections – this helps in the visual study of the tasks of stereometry, the improvement of spatial thinking.

*Advantages and disadvantages of teaching materials and the use of AR technology.*

Advantages:

1. Increase of interest in the studied material.
2. Improving the quality and effectiveness of training for account of the clarity of the material.
3. Development of spatial thinking.
4. Interactivity of training.
5. Ease of use.
6. Increase the speed of learning the material in less time.
7. Modernization of the educational process.
8. Variety of marker readings. It can be not only 3D models, but also 2D images.
9. GIFs, videos, presentations, links to various materials.

Disadvantages:

1. Supported only on modern devices.
2. The need to develop specialized applications or sites, 3D models.
3. Dependence of the quality of marker recognition on the capabilities of the camera, reading angle, lighting, distance at which the camera is located.
4. The need to enclose the QR code in contrasting frames for better recognition of markers.
5. Supported 3D models only in glTF format.

The areas of use of augmented reality (AR) are diverse: textbooks with QR codes, educational games, educational applications, programs for object modeling, applications for developing skills, and more. The most important advantage of this technology over others, to take virtual reality as an example, is mobility and relative simplicity. There is no need to purchase special equipment for it, such as glasses or helmets with motion sensors, the presence of a modern smartphone with a camera has become commonplace, so everyone can plunge into the world of augmented reality. AR makes it possible to bring educational materials to a new level of display, improving and introducing novelty into the educational process.

**References**:

1. Savelyeva, K. V. *Dopolnennaya real'nost': kul'turnyj i obrazovatel'nyj fenomen* [Augmented Reality: Cultural and Educational Phenomenon]. *Kontekst i refleksiya: filosofiya o mire i cheloveke* [Context and Reflection: Philosophy about the World and Man]. 2018. Vol 7. № 1 A, pp. 227-233. (in Russian).

2. Carpignoli, N. AR.js – The Simplest Way to get Cross-Browser Augmented Reality on the Web. URL: https://medium.com/chialab-opensource/ar-js-the-simpliest-way-to-get-cross-browser-ar-on-the-web-8f670dd45462 (date accessed: 15.02.2021).
3. Fauzi, A. Creating Web-Based Augmented Reality With Just 10 Lines of HTML Code (For Beginners – AR.js). URL: https://medium.com/@fauziali (date accessed: 20.02.2021).
4. Soloviev, M. M. 3DS Max 7 i 8. *Volshebnyj mir trekhmernoj grafiki* [3DS Max 7 and 8. The magical world of three-dimensional graphics]. Moscow: Solon-press, 2014. 529 p. (in Russian).
5. Alexandrov, A. D., Verner, A. L., Ryzhik, V. I. *Stereometriya geometriya v prostranstve* [Stereometry geometry in space]. Moscow: Alfa, 1998. 575 p. (in Russian).

**Список литературы:**

1. Савельева К. В. Дополненная реальность: культурный и образовательный феномен // Контекст и рефлексия: философия о мире и человеке. – 2018. – Т. 7. – № 1А. – С. 227-233.
2. Carpignoli N. AR.js — The Simplest Way to get Cross-Browser Augmented Reality on the Web. URL: https://medium.com/chialab-opensource/ar-js-the-simpliest-way-to-get-cross-browser-ar-on-the-web-8f670dd45462 (дата обращения: 15.02.2021).
3. Fauzi A. Creating Web-Based Augmented Reality With Just 10 Lines of HTML Code (For Beginners — AR.js). URL: https://medium.com/@fauziali (дата обращения: 20.02.2021).
4. Соловьев М. М. 3DS Max 7 и 8. Волшебный мир трехмерной графики. – М.: Солон-пресс, 2014. – 529 с.
5. Александров А. Д. Вернер А. Л., Рыжик В. И. Стереометрия геометрия в пространстве. – М.: Alfa, 1998. – 575 с.

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## MODERN SAILCLOTH: MATERIALS, TECHNOLOGIES, TRENDS

**Abstract.** The paper analyzes the composition and properties of modern sailcloth, including innovative developments of recent years, and identifies the main trends in improving their properties and production technologies.

**Keywords:** Sail, sailcloth, woven sailcloth, laminate sailcloth, composite sailcloth, membrane sailcloth, 3Di- technology, EPEX-technology.

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## СОВРЕМЕННЫЕ ПАРУСА: МАТЕРИАЛЫ, ТЕХНОЛОГИИ, ТЕНДЕНЦИИ

**Аннотация.** В работе проанализированы состав и свойства современных парусных материалов, в том числе инновационные разработки последних лет, и определены основные тенденции в совершенствовании их свойств и технологий производства.

**Ключевые слова:** парус, парусные материалы, тканые парусные материалы, ламинатные парусные материалы, композитные парусные материалы, мембранные парусные материалы, 3Di-технология, EPEX-технология.

The 21st century is a time of unprecedented growth in people’s interest in travel and extreme sports. Sailing is developing rapidly, new types of sailboats requires new sailcloth that can meet the ever-increasing requirements.

Taking into account the function of the sail and the conditions for its implementation, these requirements are determined by the values of the following indicators: [1; 23].

1. Initial modulus of stretching.
2. Breaking strength is a force per cross sectional area of material.
3. Creep shows the long term stretch of a fiber or fabric. A material with creep may have a high initial modulus, but loses its form over time.
4. Resistance to UV radiation is very important characteristic.
5. Flex strength is strength lost due to folding and bending.
6. Cost-effectiveness depend from durability of the material.

Additional requirements depend on the scope of use of the sails (racing, cruising, used in severe frost conditions, etc.). We studied modern sailcloth using literature data and websites of sail manufacturers, and identified the main trends in improving their properties and technologies for their production.

Very few sailboats, mostly participants in historical projects, use cotton and linen sails, as they did in the old days. And the vast majority of cruise ships, as well as small racing sailboats, have *woven polyester and nylon sails*.

Modern polyester for sails is Dacron, Type52, Terylene, Tetoron, Trevira, Diolen. Dacron and its analogues have a number of undoubted advantages: high tensile strength, ability to stretch under wind load, durability and UV resistance. Nylon is as

strong as Dacron, but lighter and more elastic, which is why full course sails – spinnakers and gennakers – are usually sewn from nylon. Nylon is easy to color, but is not resistant to chemicals, so its scope is limited. An important factor in favor of woven materials is their relatively low price.

However, woven fabrics have a serious drawback that becomes fatal in the long races. This is the "fatigue" of the fibers as a result of alternating stretching, which leads to the loss of the shape of the sail and a decrease in its efficiency due to a decrease in the useful pulling force. Laminate sails, devoid of this drawback, were originally designed as racing sails and are now used for cruisers as well [2].

*Laminate sail* has a combined layered structure. Usually it have light woven fabric taffeta that have been treated with anti-mildew and anti-UV additives. The taffetas protect the load bearing yarns and provide a chafe protection. Beneath the taffeta is a laminate made of a very durable yet flexible material. Several classes of fibers are used as this layer.

First of all, these are extremely strong para-aramid fibers: Kevlar, Twaron, Technora, which have high initial modulus and breaking strength. Interestingly, Russian para-aramid Rusar, due to its unique production technology, outperforms Technora and Twaron in both of these indicators. But it is not used for sailcloth production.

Polyethylenes class is represented by Pentex, Spectra, Dyneema. These are very strong and resilient fibers, but they have a high creep rate: over time, they stretch and break. Less commonly used are Liquid Crystal Polymer: Vectran, PBO (Zylon).

The most popular and very expensive class of polymers for laminate sails is Carbon, which is made up of carbon filaments. Carbon Fibers is very durable (more than para-aramids) and essentially unaffected by UV exposure. In addition, the black sails look very impressive. Carbon is often used in laminates with aramids [3].

The inner layer of the laminated sail contains elastic fibers that can withstand prolonged stress. Maylar film is usually used as an inner layer.

Laminate sails, due to their complex structure, don`t lose their effectiveness over time and better than woven ones, they withstand the negative influences of the external environment [2].

North Sails is the only manufacturer of *composite sails* in the world using the revolutionary 3Di-technology. Composites are materials that combines to maximize their strengths and minimize their weaknesses. Composite construction is different than process of lamination where a substrate (such as mylar) is used to carry adhesives and materials. 3Di sails are composed strictly of spread filaments and thermoset resin. 3Di is stronger, lighter and more resistant to environmental factors than laminate string sails. Sails builds on full-sized 3D-molds, inflated to the sail's precise flying shape. Heat and vacuum pressure are then applied, consolidating the composite structure. The sail's shape and durability are permanently locked into the rigid airfoil that is customized to the user's sailing preferences [4].

An unique EPEX technology is used by Elvstrom Sails to create so-called *membrane sails*, which in terms of characteristics and structure are located between laminate and composite sails. Using computer modeling, a fiber placement template is created for a specific sail, taking into account its individual geometry. EPEX

membranes are held in one position over the entire surface during the entire lamination process by means of a vacuum. In this case, the sail lamination is perfectly uniform [5]. Composite and membrane sailcloth, unlike laminate sailcloth, allow you to use only one set of sails, even on round-the-world races.

The strength and elasticity of the best types of sailcloth allows them to work effectively at high wind speeds, including stormy ones. Further improvement of sailing materials is aimed at increasing the durability of use by reducing brittleness at the bends of the sail and increasing its resistance to negative environmental factors. It seems to us that the use of nanotechnology and the creation of materials with programmable properties will be effective on this path. Perhaps this will allow manufacturers to move away from layering in the concept of laminated sails. At the same time, in order to popularize sailing tourism and sailing, a reasonable balance must be struck between high technology and price.

The second trend is an increase in the specialization of sailcloth, a narrowing of the range of use of a particular material. Earlier the materials were divided into 3-4 groups: sails for cruises, sails for full courses, racing sails. Now the largest sailcloth manufacturer Dimension Poliant offers a choice of 34 types of materials. However, this division may be due to not only by the function of a particular sail, but also by marketing tasks.

To summarize, it should be noted that the final appearance of the sail and its properties depend not only on the materials, but also on the technologies used by sail engineers to create the sail. The variety of modern sailboats and the development of the world sail shipbuilding will inevitably require the improvement of sailcloth and determine the progress in this area.

**References:**


1. Yeroshkina, S. (2017) Cost-effectiveness of sailcloth selection for different classes, types and species of sailing boats. *EUREKA: Physics and Engineering. (*5), p.22-29. URL: http://eu-jr.eu/engineering/article/view/417/385 (date accessed: 10.05.2021).
2. Hancock, B. (2016) Choosing the right fabric for your sails: part one. *Blue water sailing*. July, 12. URL: https://www.bwsailing.com/choosing-the-right-fabric-for-your-sails-part-one (date accessed 10.05.2021).
3. Doriomedov, M. S. *Ry`nok aramidnogo volokna: vidy`, svojstva, primenenie* [Aramid fiber market: types, properties, applications]. URL: http://viam-works.ru/ru/articles?art_id=1614 (date accessed: 10.05.2021).
4. 3Di innovative technology. URL: https://www.northsails.com/sailing/en/ innovation/3di-technology (date accessed: 10.05.2021).
5. EPEX Technology. URL: https://elvstromsails.com/technology/membrane-sail (date accessed: 10.05.2021).

**Список литературы:**

1. *Yeroshkina S.* Cost-effectiveness of sailcloth selection for different classes, types and species of sailing boats // *EUREKA: Physics and Engineering*. (5) – 2017. – С. 22-29. URL: http://eu-jr.eu/engineering/article/view/417/385 (дата обращения: 10.05.2021).
2. *Hancock B. Choosing the right fabric for your sails: part one* // *Blue water sailing.* – 2016. URL: https://www.bwsailing.com/choosing-the-right-fabric-for-your-sails-part-one (дата обращения 10.05.2021).
3. Дориомедов М. С. *Рынок арамидного волокна: виды, свойства, применение.* URL: http://viam-works.ru/ru/articles?art_id=1614 (дата обращения: 10.05.2021).
4. 3Di innovative technology. URL: https://www.northsails.com/sailing/en/innovation/3di-technology (дата обращения 10.05.2021).
5. EPEX Technology. URL: https://elvstromsails.com/technology/membrane-sail (дата обращения: 10.05.2021).

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## APPLICATION OF OXAZOLINES

**Abstract.** Oxazolines have been known since the 60s of the last century and have received practical application in medicine. Currently, the properties of oxazolines and their derivatives are being actively studied, as well as the search for new areas of their use. The work of recent years in the field of oxazolines application is considered.

**Keywords:** oxazolines, application, additive, smart polymer.

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# ПРИМЕНЕНИЕ ОКСАЗОЛИНОВ

**Аннотация.** Оксазолины известны с 60-х годов прошлого века и получили практическое применение в медицине. В настоящее время ведется активное изучение свойств оксазолинов и их производных, а также поиск новых областей их использования. Рассмотрены работы последних лет в области применения оксазолинов.

**Ключевые слова:** оксазолины, применение, добавка, умный полимер.

Oxazolines are combinations of the class of cyclic amino ethers. Oxazolines form star-shaped or brush type polymers [1]. They have been known since the 1960s, but they have not been widely used till today. Nowadays, active researching about their properties, synthesis methods, and searching for areas of their application is being performed.

Oxazolines can react in cationic polymerization while being under action of various substances, such as Lewis acids, Bronsted–Lowry acids, and alkyl halides. Chain growth occurs without irreversible breaking on the counterion, if the catalyzing acid is a weak nucliophile [1].

The most prospective field of application of oxazolines is medicine, [2] since they form smart polymers, that comply with temperature changing [3]. This fact allows them to be used for targeted drug delivery to a certain area of the body, as well as tissue repair, biosensing. Oxazoline-functionalized polymers can also be used as additives and fillers for active agent delivery systems [2].

It was also found that a triblock copolymer of the ABA type, consisting of methyl-2-oxazoline and tetrahydrofuran, can solubilize curcumin. It has a very hydrophobic molecule with multiple therapeutic effects, but its insolubility and low stability in water is a major drawback for their clinical use [3].

Oxazolines can be used to synthesize a cancer screening drug [7]. The synthesis can be carried out by dehydrogenation from thiazoline, oxazoline, and imidazoline, respectively. Dehydrogenation can also be achieved by initial halogenation of those basic cyclic systems (thiazoline, imidazoline, and oxazoline), followed by elimination to obtain target thiazole, oxazole, and imidazole derivatives.

Oxazolines can be used as a binder. For example, a copolymer containing oxazoline monomers can be used as a binder in polymer materials. Oxazoline groups react with carboxyl groups, phosphate groups, phenolic hydroxyl groups, or also with aromatic thiol groups with the opening of the cycle. When binding polycarboxylic acids, for example, polyacrylic acid latexes, react with oxazoline-modified polymers,

stable compounds of esters appear, and a reaction of oxazoline groups with carboxyl groups can often be carried out even while room temperature [4].

There are two types of binding oxazoline-functionalized polymers. Water-soluble functionalized oxazoline polymers are obtained by radical polymerization in a solution of the respective monomers. Functionalized by oxazolines, polymer dispersions (latexes) are obtained in a result of the emulsion polymerization of the corresponding monomers. When oxazolines are added to polyvinyl chloride mass, the material delamination slows, and the gas tightness increases.

When oxazolines are added to polyethylene terephthalate, the stability of the end units increases, which facilitates its processing of the polymer. Chain extensions reacting with carboxyl end groups, for example, bis – oxazolines, bisphenol-A-diglycidyl ether and polycarbodiimide (PCDI) gave a noticeable decrease in the number of carboxyl end groups, but growth of molecular weight of the polymer product was neglectible, which is due to the predominance of hydroxyl upon carboxyl end groups. One of the most common and technically available methods of processing PET raw materials is its chemical modification by introducing chain extensions into the polymer matrix of PET during its processing, which increases the viscosity.

Oxazolines can be used as intermediate compounds, precours, in the synthesis of aromas. These compounds are not toxic, so they can be used in the food industry.

There are also many synthesized luminating complexes based on oxazolines. Such complexes have greater thermodynamic stability than metal-based complexes, due to the cosloride heteroatom [5].

Thus, oxazolines can be used in medicine (the main field of application), and in the production of plastic containers. The modern world realizes research of their properties and, having been based on this, looks forways to apply them.

**References**:


1. Oxazolines. URL: https://xumuk.ru/encyklopedia/2/3031.html (date accessed: 01.04.2021).
2. Bulk Properties of Poly (macromonomer)s of Increased Backbone and Branch Lengths URL:https://pubs.acs.org/doi/10.1021/ma0016937 (date accessed: 01.04.2021)
3. Phase 2 Trial of GTx-758, an Estrogen Receptor Alpha Agonist, in Men With Castration-Resistant Prostate Cancer. URL: https://www.researchgate.net/ publication/340227065_Phase_2_Trial_of_GTx-758_an_Estrogen_Receptor _Alpha_Agonist_in_Men_With_Castration-Resistant_Prostate_Cancer (date accessed: 01.04.2021).
4. Curcumin/poly (2-methyl-2-oxazoline-b-tetrahydrofuran-b-2-methyl-2-oxazoline) formulation: An improved penetration and biological effect of curcumin in F508del-CFTR cell lines. URL: https://pubmed.ncbi.nlm.nih.gov/28427956/ (date accessed: 01.04.2021)
5. Gusev, A. N., Shulgin, V. F. *Lyuminesciruyushchie kompleksy lantanidov so spejserivannym piridiltriazolami* [Luminescent complexes of lanthanides with spasserovannym pyridyltriazoles]. *Uchenye zapiski Krymskogo federal'nogo universiteta imeni V. I. Vernadskogo* [Scientific notes of the Crimean Federal

University named after V. I. Vernadsky. Biology. Chemistry]. 2017. Vol. 3 (69). № 4, pp. 268-274.

**Список литературы:**

1. Оксазолины. URL: https://xumuk.ru/encyklopedia/2/3031.html (дата обращения: 01.04.2021).
2. Bulk Properties of Poly(macromonomer)s of Increased Backbone and Branch Lengths. URL: https://pubs.acs.org/doi/10.1021/ma0016937 (дата обращения: 01.04.2021)
3. Phase 2 Trial of GTx-758, an Estrogen Receptor Alpha Agonist, in Men With Castration-Resistant Prostate Cancer. URL: https://www.researchgate.net/publication/340227065_Phase_2_Trial_of_GTx-758_an_Estrogen_Receptor_Alpha_Agonist_in_Men_With_Castration-Resistant_Prostate_Cancer (дата обращения: 01.04.2021).
4. Curcumin/poly (2-methyl-2-oxazoline-b-tetrahydrofuran-b-2-methyl-2-oxazoline) formulation: An improved penetration and biological effect of curcumin in F508del-CFTR cell lines. URL: https://pubmed.ncbi.nlm.nih.gov/28427956/ (дата обращения: 01.04.2021)
5. Гусев А. Н., Шульгин В. Ф. Люминесцирующие комплексы лантанидов со спейсериванным пиридилтриазолами // Ученые записки Крымского федерального университета имени В. И. Вернадского. Биология. Химия. Химия. – 2017. – Т. 3 (69). – № 4. – С. 268-274.

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## GEOTHERMAL ENERGY

**Abstract**. Due to the rapid rise in the cost and complexity of the extraction of fossil fuels there is a need for the development of alternative energy sources. Geothermal energy is one of the promising industries that deserves attention. This technology of energy production is more profitable than traditional ones in many respects.

**Keywords**: renewable energy sources, geothermal energy, Climate summit, thermal waters, global energy balance.

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# ГЕОТЕРМАЛЬНАЯ ЭНЕРГИЯ

**Аннотация**: Грядущее повышение стоимости и растущие сложности при добыче ископаемого топлива вызывают необходимость развития альтернативных источников энергии. Геотермальная энергетика – одна из перспективных отраслей, заслуживающих внимания. Эта технология производства энергии выгоднее традиционных по многим показателям.

**Ключевые слова:** возобновляемые источники энергии, геотермальная энергия, Климатический саммит, термальная вода, мировой энергобаланс.

Nowadays we have the necessary resources to meet all the world's needs using traditional energy sources, namely coal, oil, gas, gas condensate, etc. And for the next couple of decades, this opportunity will remain. Moreover, the technique of field development and the technology of energy production by traditional methods will be improved which will lead to a reduction in the cost of energy. But in 20 years the situation will change dramatically. Of course, oil and gas will still be regarded as fuel for energy production, but their extraction will be much more expensive due to the complexity of the geological location. In this regard, we do not have much time to find and develop alternative energy sources. By alternative sources we mean renewable energy sources such as solar, wind, tidal energy, bioenergy and geothermal energy [1].

Geothermal energy is one of the most promising areas discussed at the international level. This is confirmed by the decision taken at the Climate summit in Paris in favor of the development of this sector. Delegates from more than 30 countries are convinced that it is necessary to increase the production of geothermal energy and voted to increase production by 500 % [2].

The decision was initiated by the International Renewable Energy Agency (IRENA). It is assumed that the growth of this industry will make it possible to prevent environmental deterioration [2].

The summit resolution states that this type of energy remains one of the most affordable, but the level of the industry development is extremely low. About 90 countries have the opportunity to develop this industry. The summit participants recognized that the obstacle to the implementation of geothermal projects is not only the environmental reasons but also the need for the investment in drilling. At the same time, the sale of electricity can be conducted as the sources are developed, without waiting for the full implementation of projects.

Geothermal energy is most effectively used in the regions where, due to natural conditions there is a large number of available hot springs and where there is a shortage

of combustible minerals or the delivery of energy resources is complicated by the inaccessibility of the area. In many countries, the heat or electricity generated by geothermal plants provides a significant share of energy costs.

Russia has abandon supplies of geothermal energy in the volcanic areas of Kamchatka, the Kuril Islands, and in foothill areas in many regions. According to estimates assessments, the possibilities of geothermal energy in Russia significantly exceed the potential of fossil fuels (up to 10-15 times). At the same time, there are explored reserves and built capacities in the country and we have to use them more effectively.

If we talk about the disadvantages of this industry, the following points should be noted:

High price: the cost of geothermal capacity plants building can be much higher in comparison to traditional ones. A significant share of investments is accounted for by exploration and drilling of wells;

Environmental problem: the content of a large number of harmful chemicals in the thermal water (arsenic, mercury, greenhouse gas emissions). Wrong handling or disposal of these chemicals may cause damage to the nature and human health;

Geographical feature of the location. Few countries have the opportunity to use this resource as high geothermal activity has the largest potential along tectonic fault lines in the earth crust [3].

Most of the problems associated with these shortcomings have already been solved by our scientists in this field. Patents and author's developments (for water treatment and re-injection, equipment design, etc.) have been created, the scientific potential has been preserved, and the technology is fully ready for implementation.

The heat of thermal waters is used in greenhouses; in medicine; treatment with mineralized thermal waters is widely used; cheap chemical products are obtained from thermal waters – iodine, bromine, boron, lithium, cesium, rubidium, strontium, etc. Their extraction from solutions does not require large capital expenditures for mining operations. Thermal waters are easily enriched by evaporation [2].

In permafrost areas covering more than 50 % of the territory of Russia open- pit mining is usually carried out only in the summer. The use of the heat of the earth's interior will allow mining operations to be carried out all year round.

At the same time, the heat produced using geothermal water is 4 times cheaper than in boiler houses. The payback period for any geothermal project is 2-3 years, while a gas field pays off in an average of 6-7 years.

Geothermal energy has an impressive potential and will play an important role in the future of the global energy balance. It will become an integral part of the renewable energy that the world needs because sooner or later fossil fuels will lose their relevance.

**References:**

1. *Geotermal'naya energetika: mirovye tendencii i rossijskie perspektivy* [Geothermal energy: global trends and Russian prospects]. URL: http://www.cleandex.ru/articles/2016/05/20/geotherm_energy_world_tendency_russian_prospects (date accessed: 08.05.2021).

2. Zenikov, S. *Perspektivy i problemy geotermal'noj energetiki* [Prospects and problems of geothermal energy]. URL: https://pronedra.ru/perspektivyi-i-problemyi-geotermalno-284614.html (date accessed: 10.05.2021).
3. *Geotermal'nye elektrostancii: preimushchestva i nedostatki* [Geothermal power plants: advantages and disadvantages]. URL: https://avenston.com/ru/articles/geothermal-pp-pros-cons/ (date accessed: 08.05.2021).

**Список литературы:**

1. Геотермальная энергетика: мировые тенденции и российские перспективы. URL: http://www.cleandex.ru/articles/2016/05/20/geotherm_energy_world_tendency_russian_prospects (дата обращения: 08.05.2021).
2. Зеников С. Перспективы и проблемы геотермальной энергетики. URL: https://pronedra.ru/perspektivyi-i-problemyi-geotermalno-2-84614.html (дата обращения: 10.05.2021).
3. Геотермальные электростанции: преимущества и недостатки. URL: https://avenston.com/ru/articles/geothermal-pp-pros-cons/ (дата обращения: 08.05.2021).

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## THE IMPACT OF CHPP ON THE ENVIRONMENT

**Abstract.** The article considers the principles of operation of combined heat and power plant from the point of view of their impact on the environment. The influence of CHPP on ecology is being evaluated.

**Keywords:** CHPP, pollution, emissions, impact on the environment, influence on ecology.

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# ВЛИЯНИЕ ТЭЦ НА ОКРУЖАЮЩУЮ СРЕДУ

**Аннотация.** В статье рассмотрены принципы работы теплоэлектростанции с точки зрения их воздействия на окружающую среду. Проводится оценка влияния электростанции на экологию.

**Ключевые слова:** ТЭЦ, загрязнение, выбросы, воздействие на окружающую среду, влияние на экологию.

The environment is the center of people's lives. But energy is an equally important part of it, because the Internet, heating, lighting, charging devices, watching a movie – all this is connected with the production of electricity. Now there are several ways to extract energy, from classical thermal power plants, nuclear power plants, hydroelectric power plants to alternative power plants (wind power plants, solar power plants).

Thermal power plants are of great concern in terms of environmental impact, since according to statistics, more than 60 % of electricity is generated there. Combined Heat and Power Plant (CHPP) is a type of Thermal Power Plant (TPP). It serves not only for the production of electricity, but also supplies hot water to the central heating system and for household needs. Unfortunately, energy production has its consequences. The most global of them is the impact on the environment [1].

Heat and power engineering is actively developing, as a result of which it has an impact on the atmosphere, hydrosphere, and lithosphere.

When converting heat energy into electricity, there are several stages, but each of them has a negative impact on the environment: extraction and processing of fuel, production of heat and electricity, transportation and disposal of waste.

It can be considered that thermal energy has a negative impact on almost all elements of the environment, as well as on humans, other organisms and their communities.

So, even before the operation of the CHPP, fuel is extracted, consider solid, for example, coal, shale, peat. As a result of this process, the destruction of soils and soil occurs if the extraction takes place by open methods. Further pollution of water systems, as a large amount of water is discharged, ferrous, with a high content of minerals. Meanwhile, ecosystems are being destroyed.

The next step is transportation. At this time, there is pollution from the evaporation of liquid fuel, loss of gas and dust from solid fuel, various leaks.

And only now the CHPP starts its work. Almost 30 % of the total volume of polluted air is due to the operation of the CHPP. More specifically, this is about six million tons of dust, harmful chemical compounds (sulfur, carbon, etc.) per year.

Especially dangerous ones are nitrogen oxides, which are the cause of acid rain, as a result of which weak acid solutions fall out in the form of precipitation [2].

Speaking about the negative impact on the environment, it is important to mention about the release of a huge amount of carbon dioxide into the atmosphere as a result of fuel combustion, that influences on the temperature of the Earth and air. Excess emissions of this gas causes global warming and increase the greenhouse effect.

CHPP emissions contain metal compounds that enter the body, soil, water, etc. There are also radioactive elements that are formed when coal is burned. The ash contains toxic metals, such as mercury, manganese, and so on, which can cause contamination of the area.

Another example of emissions are solid particles, ash and slag, which leads to changes in solar radiation in the vicinity of the Earth, as well as cause various diseases when ingested [3].

CHPP systems consume large amounts of water, as it is necessary for:

1) cooling of steam turbine condensers;
2) ash and slag removal system;
3) washing of equipment.

Meanwhile, the CHPP is also a source of heated water, which is supplied to various reservoirs. Waste water, which may contain vanadium, fluorine, petroleum products, etc., pollutes and raises the temperature, disrupting the internal balance of the environment. Thermal pollution can have a number of consequences: rising air temperatures, rising sea levels, flooding, and so on. But the impact of CHPP on the environment depends on the fuel used. Gas is the cleanest, but peat, shale, coal on the contrary. Since during their combustion, the amount of dust and sulfur oxides is maximum [4].

It is also impossible not to mention the changes in the landscape during the construction of energy facilities, the use of lithospheric resources, for example, the felling of trees, the withdrawal of arable land that could be useful in the agriculture of meadows, etc.

So, to decrease harmful effects from thermal power plants on our environment it is necessary to take the following measures:

4) take into account environmental indicators when developing heat supply schemes;
5) reduce the number of large enterprises within the city;
6) develop and implement more modern production technologies.

Thus, it became clear that the use of thermal power plants is harmful to the environment, but modern technologies are trying to reduce this influence and it is already working well now, the percentage of pollution decreases every year.

**References:**

1. *Printzip raboty i ustroystvo teplovoy electrostantzii (TES/TETZ)* [The principle of operation and the device of a thermal power plant (TPP/CHPP). Techcult]. URL https://www.techcult.ru/technology/5057-princip-raboty-i-ustrojstvo-tec-tes (date accessed: 31.03.2021).

2. *Zagryaznenie vozdukha TETZ. Ekologya TETZ* [CHPP air pollution. Ecology of CHPP] URL: https://fb.ru/article/196324/zagryaznenie-vozduha-tets-ekologiya-tets. (date accessed: 27.03.2021).
3. *Vliyanie vrednykh vybrosov TETZ na atmosferu* [The impact of harmful emissions of thermal power plants on the atmosphere]. URL: https://vuzlit.ru/1334671/vliyanie_vrednyh_vybrosov_atmosferu (date accessed 03.05.21).
4. Bondarchuk, E. N., Smolin, A. A. *Ekologicheskyi monitoring TETZ* [Environmental monitoring of CHPP]. URL: http://www.boner.ru/index.php?action=topics&menu_id=225&page_id=126 (date accessed: 03.05.2021).

**Список литературы:**

1. Принцип работы и устройство тепловой электростанции (ТЭС/ТЭЦ). Техкульт. URL https://www.techcult.ru/technology/5057-princip-raboty-i-ustrojstvo-tec-tes (дата обращения: 31.03.2021).
2. Загрязнение воздуха ТЭЦ. Экология ТЭЦ. URL: https://fb.ru/article/196324/zagryaznenie-vozduha-tets-ekologiya-tets (дата обращения: 27.03.2021).
3. Влияние вредных выбросов ТЭЦ на атмосферу. URL: https://vuzlit.ru/1334671/vliyanie_vrednyh_vybrosov_atmosferu (дата обращения 03.05.21).
4. Бондарчук Е. Н., Смолин А. А. Экологический мониторинг ТЭЦ. URL: http://www.boner.ru/index.php?action= topics&menu_id=225&page_id=126 (дата обращения: 03.05.2021).

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## METAL WASTE RECYCLING

**Abstract.** This article considers various methods of metal waste recycling, ways of their preparation for recycling and the classification of metal waste is also given.

**Keywords:** waste recycling, metals, metal waste.

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# ПЕРЕРАБОТКА ОТХОДОВ МЕТАЛЛОВ

**Аннотация.** В работе рассматриваются различные методы переработки отходов металлов, способы их подготовки к переработке, а также приводится классификация металлических отходов.

**Ключевые слова:** переработка отходов, металлы, отходы металлов.

The problems of utilization, recycling and reuse of metal waste are relevant today. Every year the number of metal waste increases, the requirements for their disposal become tougher and energy resources get more expensive.

The secondary use of metals can significantly affect the economy. Since it has become more difficult and expensive to obtain metal from ore due to its large depth, distance from processing sites and high energy consumption, at the moment only 70 % of the metal is obtained from it, and everything else goes to waste [1; 165]. Recycling and reuse of these wastes will reduce the cost of manufacturing products containing metals.

In addition, many metal wastes belong to the first class of danger. If they are not recycled, they will cause irreversible damage to the environment. Metal waste enters the environment through its dispersion in all ecosystem environments (atmosphere, hydrosphere, lithosphere). The concentration of metals in the environment can change both naturally (redistribution between the land surface, water and atmosphere) and artificially, as a result of measures taken by human. Any contamination usually doesn’t become immediately noticeable, it often has a hidden character. Not only emissions of harmful substances can be dangerous, but also any other substances that aren’t characteristic of the ecosystem [2; 1085].

Classification of metal waste in our country is carried out according to State Standards. According to them, metal waste is divided into ferrous and non-ferrous metal waste. Ferrous metals are divided into different groups, according to different indicators: by the carbon content (steel scrap and waste, where the carbon content is less than 2 %, and cast-iron scrap and waste, where the carbon content is more than 2 %), by the presence of alloying elements (carbon and alloyed), by quality indicators. Non-ferrous metals, in turn, are divided into 17 groups: aluminum and aluminum alloys, tungsten and tungsten containing chemical compounds, tungsten alloys, cadmium and cadmium compounds, cobalt, its compounds and alloys, magnesium and magnesium alloys, copper, brass, bronze, molybdenum, molybdenum-containing chemical compounds and alloys, nickel and nickel alloys, tin and tin-lead alloys, mercury and its compounds, lead and lead alloys, titanium and titanium alloys, zinc and zinc alloys, composite scrap, bimetals.

Before recycling, metal waste undergoes a number of operations for preparation, which are described in the sources [3; 101] and [4; 218]. The first stage of processing, as a rule, is crushing. The crushed waste contains many different impurities, so after crushing, the mechanically separated fractions are separated from each other. Also, mechanical methods of waste crushing include waste crushing by explosion energy, copra crushing, cryogenic crushing and scrap metal cutting. Metal cutting includes four types: gas (oxygen) cutting, gas-arc cutting, plasma cutting and drilling with an oxygen spear.

Further, the crushed waste goes through the sorting stage by various methods, such as magnetic separation, eddy current separation, air separation, screening and electric sorting.

After grinding and sorting, the scrap goes through the stage of packaging (for heterogeneous waste) and briquetting (for homogeneous waste).

Also, when preparing waste for processing, pyrotechnic control is carried out – control of scrap metal and metal waste in order to detect and remove explosive objects and flammable substances from them. Waste passes pyrotechnic control twice: by the delivery company and by the procurement company.

There are a huge number of technologies for recycling scrap metal, which is due to the variety of metals that make up this waste, as well as a fairly large number of impurities, the removal of which requires additional operations.

One of the most common methods is the leaching of metals. Let's consider this method in more detail on the example of aluminum waste.

The process of recycling aluminum-containing waste begins with the production of alkaline-aluminate solutions, which are obtained by the interaction of aluminum or its oxide and hydroxide with the transformation of the $OH^-$ group of the alkaline solution into a complex ion. The reaction equations of this process are given in the source [5; 428] and are shown in Table 1.

Table 1

Preparation of alkaline-aluminate solutions

| | |
|---|---|
| Al | $Al_{тв.}+OH^-+3H_2O=Al(OH)^-_{4aq}+1{,}5H_2$ (1) |
| $Al(OH)_{3\ аморфный}$ | $Al(OH)_{3т,\ аморфный}+OH^-_{aq}= Al(OH)^-_{4aq}$ (2) |
| $Al(OH)_{3\ байерит}$ | $Al(OH)_{3тв}+ OH^-_{aq}= Al(OH)^-_{4aq}$ (3) |
| $Al(OH)_{3\ бемит}$ | $AlO(OH)+ OH^-_{aq}+H_2O=2Al(OH)^-_{4aq}$ (4) |
| $Al(OH)_{3\ диаспор}$ | $AlO(OH)+ OH^-_{aq}+H_2O=2Al(OH)^-_{4aq}$ (5) |
| $\alpha\text{-}Al_2O_{3(тв.)\ корунд}$ | $\alpha\text{-}Al_2O_{3тв}+3H_2O+2OH^-=2Al(OH)^-_{4aq}$ (6) |

Aluminum waste includes a large number of different aluminum alloys that contain other metals, such as calcium, magnesium, copper, manganese, silica, zinc, and iron. These alloys should be considered as a uniform distribution of elements in the crystal lattice of an aluminum alloy.

When aluminum alloys come into contact with water and alkali, local galvanic cells occur. To estimate the dissolution of the aluminum components, the authors of

the source selected the Gibbs free energy (the values are shown in Table 2), which is related to the electromotive force of the element by the equation:

$$\Delta G_{298}^{0} = nFE^{0},$$

$\Delta G_{298}^{0}$ – Gibbs energy, n – ion charge capacity, F – the Faraday constant, equal to 96485 Cl/mol.

Table 2

Gibbs free energy

| Alloy Element | Chemical reaction | $\Delta G_{298}^{0}$, kJ/mol | Standard potentials of metals, V |
|---|---|---|---|
| Бериллий | $Be_{тв}+2OH^{-}+2H_2O=Be(OH)_4^{2-}+H_2$ | -309,38 | -1,847 |
| Алюминий | $Al_{тв.}+OH^{-}+3H_2O=Al(OH)_4^{-}+1{,}5H_2$ | -337,77 | -1,66 |
| Марганец | $Mn_{тв}+OH^{-}+2H_2O=Mn(OH)_3^{-}+H_2$ | -97,32 | -1,18 |
| Хром | $Cr_{тв}+OH^{-}+2H_2O=Cr(OH)_3^{-}+H_2$ | 49,27 | -0,852 |
| Цинк | $Zn_{тв}+2OH^{-}+2H_2O=Zn(OH)_4^{2-}+H_2$ | -74,05 | -0,763 |
| Кадмий | $Cd_{тв}+2OH^{-}+2H_2O=Cd(OH)_4^{2-}+H_2$ | 46,76 | -0,403 |
| Железо | $Fe_{тв}+2OH^{-}+2H_2O=Fe(OH)_4^{2-}+H_2$ | 35,64 | -0,037 |
| Кремний | $Si_{тв}+2OH^{-}+2H_2O=H_2SiO_4^{2-}+2H_2$ | -398,63 | - |
| Медь | $Cu_{тв}+2OH^{-}+2H_2O=Cu(OH)_4^{2-}+H_2$ | 152,09 | +0,337 |

These compounds, as a result of a chemical reaction, release hydrogen from water; and the main role of alkali is the dissolution of hydroxide.

For aluminum, the process is as follows:

I. $Al+H_2O=Al(OH)_3+1{,}5H_2$

II. $Al(OH)_3+OH^{-}=Al(OH)_4^{-}$

Since the resulting aluminum hydroxide is an amphoteric compound, it then exhibits acidic properties and is easily neutralized by alkali to form a complex compound. Silica behaves the same way.

Elements that exhibit basic properties, even when dissolved in an alkaline solution, will be represented only by hydroxides. Therefore, for the processing of aluminum waste, it is necessary to apply a thermodynamic approach to the analysis of the behavior of all components when they are dissolved in an alkaline solution. The development of the technological process begins with the determination of the amount of aluminum oxide, which can be converted into an alkaline-aluminate solution.

The dissolution of the aluminum alloy and its components is possible only when free caustic alkali is present in the solution. However, it should be taken into account that the process of dissolution of the alloy occurs in reactors with an open surface, so caustic alkali is able to absorb carbon dioxide from the air:

$$2NaOH+CO_2=Na_2CO_3+H_2O$$

As a result, the amount of free alkali decreases.

So, the sphere of use of secondary metals in the world is at the stage of active development. Modern researchers are improving old technologies and developing fundamentally new ones.

**References:**

1. Kalacheva, O. A. *Vtorichnoe ispolzovanie metallov i splavov*. [Secondary use of metals and alloys]. *Transport: nauka, obrazovanie, proizvodstvo* [Transport: Science, Education, Production: Proceedings of the Research and Practice Conference]. Voronezh, 2019, pp. 165-166. (in Russian).
2. Galtman, N. A. *Otsenka opasnosti metallurgicheskogo proizvodstva*. [Risk assessment of metallurgical production]. *Pogarnay bezopasnost: problem i pespectivy*. [Fire safety: problems and prospects]. Ivanovo, 2018, pp. 1085-1088 (in Russian).
3. Mysik, V. F., Zhdanov, A. V. *Resursy i podgotovka loma k plavke stali: monografiya*. [Resources and preparation of scrap for steel melting: monograph]. Ekaterinburg: Ural Federal University, 2017, pp. 101-155. (in Russian).
4. Bobovich, B. B., Devyatkin, V. V. *Pererabotka othodov proizvodstva I potrebleniya.* [Recycling of production and consumption waste]. Moscow: Intermet Engineering, 2000, pp. 218–238. (in Russian).
5. Alekseev, A. I. *Nauchnyi osnovy pererabotki aluminii soderzgachih othodov.* [Scientific basis for processing aluminum-containing waste]. *Zapiski Gornogo instituta*. [Notes of the Mining Institute]. SPb. 2016, pp. 428-434 (in Russian).

**Список литературы:**

1. Калачева О. А. Вторичное использование металлов и сплавов // Транспорт: наука, образование, производство. («Транспорт-2019»). – 2019. – С.165-166.
2. Гальтман Н. А. Оценка опасности металлургического производства // Пожарная безопасность: проблемы и перспективы. – 2018. – С.1085-1088.
3. Мысик В. Ф., Жданов А. В. Ресурсы и подготовка лома к плавке стали. – Екатеринбург: УрФУ, 2017. – С. 101-155.
4. Бобович Б. Б., Девяткин В. В. Переработка отходов производства и потребления. – М: Интермет Инжиниринг, 2000. – С. 218-238.
5. Алексеев А. И. Научные основы переработки алюминий содержащих отходов // Записки Горного института. – 2016. – Т. 219. – С.428-434.

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## LEGAL ASPECTS AND HISTORY OF UAV USE

**Abstract**. This work examines the problems of UAVs in modern conflicts, their history and legal aspects of their use, as far as from the point of view of modern law, the use of UAVs is legitimate

**Keywords**: UAV, battlefield, operator, soldier, aircraft.

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## ПРАВОВЫЕ АСПЕКТЫ И ИСТОРИЯ ПРИМЕНЕНИЯ БПЛА

**Аннотация.** Данная работа рассматривает проблематику БПЛА в современных конфликтах, их историю и правовые аспекты их применения, а также насколько с точки зрения современного права применение БПЛА является правомерным.

**Ключевые слова:** поле боя, оператор, солдат, самолет.

The combat use of UAVs in international conflicts is regulated by the norms of international humanitarian law, although arms treaties or other legal treaties in the field of IHL do not contain specific references to them. The use of UAVs, as well as other types of weapons, implies that it should not be aimed at destroying the civilian population or civilian infrastructure that is not strategically important for the enemy, which is why the party with the UAV should separate the objects of the strike before using it, it is also worth noting that the international convention stipulates that UAVs can not carry prohibited weapons(nuclear shells, biological, chemical weapons, and also for some countries nuclear bombs).

From the point of view of international humanitarian law, any type of weapon that allows attacks to be carried out with a greater degree of accuracy and avoids the associated loss of civilian life, injury to civilians and damage to civilian objects should be given preference over those types of weapons that do not provide such capabilities. Whether such advantages are given by UAVs depends on the specific circumstances

of a particular case. This issue is the subject of ongoing discussion, in part because of the lack or scarcity of information about the consequences of most UAV attacks.

If the UAV is not involved in combat operations, then the norms of international humanitarian law no longer work here. In the Russian Federation has a number of normative legal acts that regulate the use of UAVs: The decree of the President of the Russian Federation dated 05.05.2004 580 N "On approval of List of goods and dual-use technologies that can be used to create weapons and military equipment, and subject to export control" "Air code of the Russian Federation" dated 19.03.1997 N 60-FZ Responsibility of the UAV operator.

Like an ordinary soldier on the battlefield, the UAV operator fights only at a great distance from the theater of operations, respectively, the operator is responsible for his decisions like an ordinary soldier, which is why his operator is responsible for the launched missile from the UAV. As a rule, the operator acts under a responsible command-therefore, according to the norms of international humanitarian law, UAV operators and their commanders are responsible for their actions. The fact that they are thousands of kilometers away from the battlefield does not relieve the UAV operators and their commanders from their duties, which include observing the principles of distinction and proportionality, as well as taking all necessary precautions when carrying out an attack. Thus, the duties of UAV operators in the field of compliance with international humanitarian law are no different from the duties of pilots of crewed aircraft, such as helicopters or other combat aircraft. As with the pilots of combat aircraft, the rules of international humanitarian law state that they can be attacked in relation to UAV operators.

In 2003, drones were openly used in Iraq. The main task of the drones was reconnaissance. First of all, it was necessary to identify the land mines installed along the main roads and, if possible, follow the enemy forces to their hiding place. After a while, the idea of using drones met with protest from Air Force officers. They were afraid that drones would gradually take their place and did not want to share the battle glory with the operators of "radio-controlled toys". Requests from the strike group command in Iraq for the supply of drones were blocked at the level of the US Air Force leadership.

By 2009, more UAV operators were trained than combat aircraft pilots. The dominant role of drones in modern combat tactics continues to this day. Depending on the type of machine, it can perform the following tasks:

- Intelligence.
- Transfer of data to the control point in online mode.
- Aiming missiles and artillery at enemy positions.
- EW-jamming the enemy's communication channel.
- Retransmission. With the help of several drones, you can create a chain through which an encrypted signal will be transmitted.
- Drop bombs and launch missiles from the board.
- As a target duringair defense repulse exercises.

The US is most actively using combat drones. The devices are mainly used in combat operations and anti-terrorist operations in the Middle East. The exact number of deaths from the actions of drones is unknown. For example, according to the CIA,

in the period from 2004 to 2016, up to four thousand people died from the actions of American drones in Pakistan, of which one thousand were civilians. The main problem of conducting a war with the use of drones is a large number of civilian casualties. Other issues include:

- Artificial intelligence is used to recognize targets, the AI can not distinguish the enemy from a civilian or a prisoner of war.
- Availability of the technology. Terrorists can buy drones on the black market and use it for their own purposes.
- Terrorists can use civilian models of drones to carry out attacks in cities in Europe and the United States. For example, to spray toxic or radioactive substances over mass gatherings of people.
- The legal aspects of the use of such machines have not yet been resolved. Accordingly, operators can be convicted.

**References:**


1. *Ukaz Prezidenta RF ot 05.05.2004 N 580 "Ob utverzhdenii Spiska tovarov i tekhnologij dvojnogo naznacheniya, kotorye mogut byt' ispol'zovany pri sozdanii vooruzhenij i voennoj tekhniki i v otnoshenii kotoryh osushchestvlyaetsya eksportnyj control"* [Decree of the President of the Russian Federation of 05.05.2004 N 580 "On Approval of the List of Dual-Use Goods and Technologies that Can be Used in the Creation of Weapons and Military Equipment and in respect of which export Control is carried Out"].
2. *"Vozdushnyj kodeks Rossijskoj Federacii" ot 19.03.1997 N 60-FZ* ["Air Code of the Russian Federation" of 19.03.1997 N 60-FZ].
3. Fuller, D., Frederik, Ch. *Oruzhie v istorii. Ot prashchi do yadernoj bomby* [Weapons in history. From a sling to a nuclear bomb]. M.: Centrpoligraf. 2012. 286 p.


**Список литературы**


1. Указ Президента РФ от 05.05.2004 N 580 «Об утверждении Списка товаров и технологий двойного назначения, которые могут быть использованы при создании вооружений и военной техники и в отношении которых осуществляется экспортный контроль».
2. «Воздушный кодекс Российской Федерации» от 19.03.1997 N 60-ФЗ
3. Фуллер Д., Фредерик Ч. Оружие в истории. От пращи до ядерной бомбы. – М.: Центрполиграф. 2012. – 286 с.

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## SOME WAYS TO MAKE SCIENCE AMAZING

**Abstract**. This article is devoted to the topic of popularization of science among young people. The authors believe that the popularization of science will contribute to technical and societal progress. The article suggests some ways and possibilities to make science amazing for young people.

**Keywords**: science, knowledge, modern technology, development of scientific interest.

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## НЕСКОЛЬКО СПОСОБОВ СДЕЛАТЬ НАУКУ УВЛЕКАТЕЛЬНОЙ

**Аннотация.** Статья посвящена теме популяризации науки среди молодежи. По мнению авторов, популяризация науки будет способствовать техническому и общественному прогрессу. В работе предлагаются способы, как сделать науку привлекательной для молодежи.

**Ключевые слова:** наука, знания, современная технология, развитие научного интереса.

We live at the age of advanced science and technology and every single aspect of our life is greatly affected by scientific progress and various inventions. We can name innumerable ways in which the humankind has benefited from contributions of science and it continues to do so. But many of us think that science is something very serious done by people in special suits behind closed doors in laboratories and accept as truth the knowledge that has been produced in these very laboratories. Consequently, many people perceive science as inaccessible and boring, because they have only encountered it in the pages of school and university textbooks. But are they right? Is it possible to develop people’s interest in scientific knowledge? In the following article, I will present a brief discussion on how science may become amazing for young people.

What do we know about science? “Science is the study of the structure of natural things and the way that they behave” [1]. A complex concept, isn’t it? Let me try to explain in simpler terms: science is a system of knowledge about everything around us.

Undoubtedly, science is complicated as for centuries, people have been gathering more and more knowledge about the world around them and trying to systemize it.

The education system invites us to get knowledge accumulated over thousands years from textbooks on various subjects in the school curriculum and it worked successfully a hundred years ago. But in the 21st century, the idea of comprehending science from textbooks seems boring to many people as there are lots of other sources to get scientific information in a more interesting way.

So, what can we do to make science amazing?

Firstly, we need to understand that most of our worldviews are formed at a young age. It is evident that the preconditions for creativity and interest in science are established at preschool age, although subjectively the child is constantly discovering new things in later periods of development [2]. This is why it is worth paying close attention to the popularization of science among children.

In my opinion, the most necessary thing we can do to develop children’s interest in science is not to leave their questions unanswered even if they seem ridiculous. Toddlers often ask adults questions like “Why is the sky blue?”, “Why does the sun shine during the day and the moon at night?”, “Why can birds fly and I can’t?” and many more things that a child cannot understand. If you do not know the answer, then look for it together. In this way, you will encourage your child to develop an interest in learning new information by your own example.

The second prerequisite thing is to explain things in a simple language and to present scientific material in an accessible way as a child will not understand complex scientific terms and formulas.

The next important point in developing children’s interest in science is to popularize science in sources accessible to children. Today almost every child has a gadget: a phone or a tablet. Now we will not consider the negative factors that affect children. I will look at how modern technology can be used to get children interested in science.

A lot of social media and bloggers can be a good way for popularizing science as it applies not only to children, but to anyone in general. There is already a huge number of popular science websites and channels where people have access to scientific information presented in plain language. When the tablet becomes an element of learning, children become more engaged in the learning process [3]. If the network is guided by the development of scientific interest, I am sure we will get good results in the near future.

In addition, the opportunity of a direct participation in a process may have a strong impact on the development of children’s interest in science. For example, museums that currently promote science to the masses have classes where anyone can take part in various investigations. I am convinced that the chance to take part in a scientific experiment will leave a child with an enjoyable impression of science. What

is more, you do not have to go to museums to conduct scientific experiments – you can do them at home. For example, it is possible to grow salt and sugar crystals at home, as well as sprout bean or flower seeds.

What can we do next?

It would good to modify the school system for learning science. Certainly, all school subjects – from history to physics – are important but you cannot force a teenager to study every area of science substantially. This can have a negative effect on their attitude towards science in general.

It is necessary to let the teenager try everything and select the most interesting area of scientific knowledge. Other areas should be studied for the proper formation of the worldview and general development, but not by requiring detailed knowledge of every topic.

In addition, it is important to realize that learning only theory is bad for the teenager's attitude towards science. Digital technology is now becoming the most convenient way of getting and sharing information [3]. Therefore, it is necessary to use modern technologies and interactive methods of teaching to make science useful and fascinating. For example, to arrange excursions to history museums for those who are interested in history, to botanical gardens for those who are interested in biology etc. The digital generation, which is our future, cannot and should not be brought up in the style our parents learned [3].

What can be done to ensure that science does not lose its fascination for adults? When the teenagers become university students, their interest in science depends directly on opportunities. At university, the student can get help from qualified and experienced teachers, support from his or her peers and perhaps even some financial support for his or her research. At this age, science becomes more practical. Various university societies promote participation in scientific conferences. Moreover, there is the opportunity to participate in serious competitions, and as you know, competition often pushes you to research and implement something new.

It is important to note that at none of the stages the individuality should be suppressed. Only if a person feels comfortable expressing him or herself when acquiring and processing knowledge, science will be fun.

In conclusion, I would like to go back to where I started my discussion. I started with a complex definition of science written in the textbook, which is difficult to understand from the first reading. In my paper, I wanted to show that science is all around us every day because everything that happens around us is science. The computer in which this paper was created, the car that drove by the window, the flower growing on the windowsill – these are all processes that I understand because of science.

It is necessary to understand that interest in science should be developed from childhood onwards, so that it can develop into a lifelong endeavor and new socially important knowledge and inventions.

The system for acquiring scientific knowledge should be structured in such a way that each person with his or her own particular characteristics can access the information he or she is interested in and express own attitudes and thoughts on the subject.

Undeniably, by using all the resources available in today's world, it is possible to make science amazing for everyone.

**References:**


1. Cambridge Dictionary. URL: https://dictionary.cambridge.org/ru/ (date accessed: 28.04.2021)
2. Abitova, G. T. Formation of the bases of information outlook of preschoolers by means of cultural creative technologies URL: https://cyberleninka.ru/ (date accessed: 30.04.2021)
3. Tosheva, M. M. Prospects for the use of modern digital technologies in education URL: https://cyberleninka.ru/ (date accessed: 02.05.2021)


**Список литературы:**


1. Cambridge Dictionary. URL: https://dictionary.cambridge.org/ru/ (дата обращения: 28.04.2021)
2. Абитова Г. Т. Формирование основ информационного мировоззрения детей дошкольного возраста средствами культуротворческих технологий. URL: https://cyberleninka.ru/ (дата обращения 30.04.2021)
3. Тошева М. М. Перспективы использования современных цифровых технологий в образовании. URL: https://cyberleninka.ru/ (дата обращения 02.05.2021)

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# STRUCTURE OF PUBLIC EXPENDITURE UNDER THE PANDEMIC CONDITIONS

**Abstract.** This article lets everyone identify the main consequences of the coronavirus pandemic for work of the Russian Government. As a result of the research, major changes in the structure of the expenditure part of the State budget will be represented and explained.

**Keywords:** budget, government, salary, gross domestic product, government deficit, social policy.

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# СТРУКТУРА РАСХОДНОЙ ЧАСТИ ГОСУДАРСТВЕННОГО БЮДЖЕТА В УСЛОВИЯХ ПАНДЕМИИ

**Аннотация.** В работе рассматриваются основные изменения в деятельности Правительства РФ в эпоху пандемии коронавируса. В результате анализа представлена обновленная структура расходной части государственного бюджета, возникшая на основе множества факторов.

**Ключевые слова:** бюджет, правительство, заработная плата, валовой внутренний продукт, дефицит бюджета, социальная политика.

In the Russian Federation, as it was in many countries all over the world, 2020 became a real challenge. According to report of the Russian Government, which has been published recently, revenues from a variety of industries really decreased. Many companies faced new range of problems, whereas they had no possibility to stabilize their own budgets except from asking for public support. It meant that Ministry of Finance of the Russian Federation had been responsible for restructuring of the

expenditure part of the federal budget. Moreover, there was news that taxes and other meaningful revenues for the state had not remained on the level of previous years. This situation could not be managed by using traditional methods of lower interest rates. That is why all these key changes caused by the coronavirus pandemic are followed by the reallocation of funds in the federal budget.

The President of the Russian Federation firstly addressed to nation on March 25, 2020. He noticed that, just like other countries' economies, the Russian economy is experiencing substantial headwinds due to the effects of the epidemic. In that speech consumer loan and mortgage holidays were declared, Vladimir Putin asked the Government and the parliament to expedite approval of the necessary regulatory changes. Finally, he told citizens that it was necessary to defer all taxes on small and medium-sized businesses, except for VAT, for the next six months, meanwhile micro businesses should also be granted a deferral on their contributions to social insurance funds [1; 3]. This event was such as an accurate step, which the Government and Staff of the Presidential Executive Office had planned before.

To begin with, we should summarize meaningful obstacles, which took place in the first quarter of the previous year. Our country, how it was noticed, turned out in the difficult and depressive conditions. Apart from the fact that stabilization of the national economic is a complex and long process, the impact of the coronavirus pandemic on the Russian business and the financial sector will feature in a steady reduction of the core economic indicators. It can be represented as a situation, in which Russian gross domestic product falls and its growth slides to -4.8 %. To capture the economic impact of a global pandemic, many researchers all around the world assume that all countries face a severe shock–equivalent to the drop in growth China, which was determined as the first example of regression, was suffering in the first quarter [2; 1]. This description helps us understand why Russian entrepreneurs, banks, insurance companies and other entities were on the verge of ruin. So, on the one hand, this address to the nation was arguable for many of them, but, on the other hand, for them it widened the opportunities provided by the Ministry of Finance of the Russian Federation. For instance, many Russian citizens were protected from the problem of unemployment, postponed timing of paying taxes contributed to saving money for payment of salaries in time.

Nevertheless, our country was not ready for lockdown, which had been saving for a whole month. These obstacles became the main reason for enhancement of financial and social support. Our Government suggested payments for those families, who have children under 16 years old. Moreover, Russian doctors and nurses were rewarded with special payments, too, because their bravery, heroism and dedication had no chance to be left without attention. In my opinion, these solutions were totally right, this is a part of social politics and moral attitude to our native people. However, all of them expanded the expenditure part of the State budget. In the middle of the previous year, it was the main challenge in which the Government of the Russian Federation tried to find how to upgrade the level of export incomes. Attempt to generate revenues in oil and gas industry would be dead-end, so it was essential to find alternatives and change the structure of public expenditure.

Table 1

Comparison of public expenditure in 2019 and in 2020 (bln rub)

| Expenditures | 2019 | 2020 |
|---|---|---|
| National Economy | 2827,10 | 3483,90 |
| Housing and Utilities Infrastructure | 282,2 | 371,5 |
| Environment Protection | 197,6 | 260,6 |
| Education | 826,5 | 956,9 |
| Culture and Cinematography | 122,4 | 144,5 |
| Health Care | 713 | 1334,40 |
| Social Policy | 4882,80 | 6900,30 |

As it was noticed earlier, the main source of public revenues related to commodity prices. Sergey Konygin, the analyst of the Russian economic and foreign exchange markets in Gazprombank, told in the interview that, due to the negative trend in mineral production, low oil prices, weak export dynamic and poor transport activity would be considered as parameters, explaining this significant decline of revenues. He noticed that it could be about 2-3 percentage points of GDP [3; 284]. That is why the Russian Government tended to identify some appropriate consequences of this process and take some actions to mitigate negative impacts of government deficit. It was impossible to cut down labor costs because employees of public organizations such as doctors and nurses in hospitals and polyclinics, teachers at schools, soldiers, border guards and others continued working tirelessly and helped to save many spheres of social life.

In addition, it is important to remember that many ecological problems were solved by the Ministry of Natural Resources and Environment of the Russian Federation in 2020. We can see in the table 1 that the Russian government spent 260 billion rubles on the environmental protection and liquidation of the negative and destroying consequences of diseases in Norilsk and on the Kamchatka peninsula. Obviously, this sum is bigger than in 2019, so Russian economic was influenced by pandemic, different diseases, and financial crisis.

Finally, we should consider main tendencies remained in the Russian Government’s fiscal policy after all social, economic, cultural, sport, ecological and other processes, or events, which took place in 2020. Due to all examples, which were represented in this article, it is necessary to identify changes in direction of development of the national economy. Firstly, many actions of our Ministries become more human-centered. Russia becomes more socially oriented, and the Government is ready to modify its fiscal policy. Secondly, the Russian standard of living can be improved because of growth of the public expenditures on culture, health and care of the population. It will be a new step to improvement of the quality of public services in the Russian Federation and expansion of the social values to the national economy.

**References:**

1. Putin, V. Address to the Nation on March 25, 2020. *The Russian Kremlin*, 1-2. URL: http://en.kremlin.ru/events/president/news/63061 (date accessed: 31.03.2021).
2. Orlik, T., Rush, J., Cousin, M., Hong, J. (2020) Coronavirus Could Cost the Global Economy $2.7 Trillion. *Bloomberg Economics*. 1-3. URL: https://www.bloomberg.com/graphics/2020-coronavirus-pandemic-global-economic-risk (date accessed: 25-03-2021).
3. Maksimova, E. V., Ryabtsev, A. G., Sazonova, O. A. *Vliyanie koronavirusa na ekonomiku Rossii: Nauchno-issledovatel'skij zhurnal "Innovacii i investicii"*. [Coronavirus Influence on the Economy of Russia: Research Journal "Innovation and Investment"]. 2020. № 4, pp. 283-286 (in Russian).

**Список литературы:**

1. *Putin V.* Address to the Nation on March 25, 2020. // *The Russian Kremlin*. – 2020. – С. 1–2. URL: http://en.kremlin.ru/events/president/news/63061 (дата обращения: 31.03.2021).
2. *Orlik T., Rush J., Cousin M., Hong J.* Coronavirus Could Cost the Global Economy $2.7 Trillion. // *Bloomberg Economics*. – 2020. – С. 1–3. URL: https://www.bloomberg.com/graphics/2020-coronavirus-pandemic-global-economic-risk (дата обращения: 25-03-2021).
3. Максимова Е. В., Рябцев А. Г., Сазонова О. А. Влияние коронавируса на экономику России // Научно-исследовательский журнал «Инновации и инвестиции». – 2020. – №4. – С. 283-286.

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## RUSSIAN CONSUMERS SAY "NO" TO ELECTRIC CARS

**Abstract**. In our article, we investigate the dynamics of Russian consumer demand in the electric car market. The work is based on the questionnaire method, which identifies the main reasons for the reluctance to purchase eco-friendly cars.

**Keywords**: eco-friendly cars, Russian consumers, reasons for law demand.

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# РОССИЙСКИЕ ПОТРЕБИТЕЛИ ГОВОРЯТ «НЕТ» ЭЛЕКТРОАВТОМОБИЛЯМ

**Аннотация**. В статье исследуется динамика спроса российских потребителей на рынке электромобилей. В основу работы положен метод анкетирования, в результате которого выявлены основные причины нежелания приобретать экологичные автомобили.

**Ключевые слова**: экологичные автомобили, российские потребители, причины низкого спроса.

Nowadays, the transport sector has received rapid development. It permeates all urban infrastructures. Thanks to scientific and technological progress, now people have the opportunity to save time on moving around the city. Every second family has a car, every sixth family owns two or more cars. The rapid growth of the passenger car fleet has threatened the environment. The problem of ecology faced humanity before, but the dynamics of environmental pollution forced to actively develop the market for environmental goods and services. One of the most important developments was an electric car [1].

According to the International Energy Agency for 2016, residents of Norway have the largest share of electric vehicles (28.76 %), Sweden (3.41 %) and the Netherlands (6.39 %) also occupy the leading place [2].

In Russia, environmental cars occupy a small market share and are not in great demand. This is due to many factors. However, in the Russian electric car market, such models as the Nissan Leaf, Tesla Model S, Tesla Model X, Tesla Model 3, Audi E-Tron are in demand [3].

Demand for electric cars among Russians is small due to their high cost. The cost of the Nissan Leaf – the most affordable model in the segment – ranges from 450,000 rubles for a 2012 car. For a 2016, you will have to pay more than 1 million rubles. Tesla Model 3 is sold in Moscow for 4.7-6 million rubles, model S – for 9-11 million rubles, X – for 9-11.6 million rubles [4].

For a more detailed study of the causes of low consumer demand, we compiled and conducted a survey. The survey was conducted among people who already have a car and among those who are thinking about buying a car. The survey consists of 5 questions that cover the most important aspects of the topic. According to the results of the survey, the number of participants was 50 people. The survey result can be found below.

Most respondents, under unchanged circumstances, would choose between an ordinary car and an electric car – an ordinary one (64 %), despite the fact that many of the respondents (58 %) believe that servicing a regular car is more expensive. However, if their place of residence were equipped with equipment for holding electric vehicles, the predominant majority (79 %) would choose an electric car as a means of transportation. In addition, the main shortcomings, according to respondents, are: the lack of charging stations, low battery capacity, long charging and low engine power. But many called the prospect of abandoning ordinary cars and switching to electric cars optimistic. In their opinion, this will help to clean the environment, but may also cause new problems, since the disposal of used batteries can lead to unforeseen circumstances. And the refusal to produce gasoline in such an amount as at present can lead to a decrease in the incomes of countries, for example, in our country almost the entire economy is built on the oil and gas industry and the rejection of gasoline will lead to a significant decrease in income.

Based on all the above facts, we can conclude that the prospect of the transition of most people to electric cars cannot be called either optimistic or pessimistic. Like every revolution – in our case in the field of transport – it carries both positive changes and negative ones. Unfortunately, at this time our country is not ready for the transition, since it cannot adequately finance the integration of equipment designed for the optimal functioning of electric cars inside Russia. However, some people consider this transition very optimistic, but everything rests on the fact that there is no suitable equipment and people have to abandon this idea and buy ordinary cars that pollute our environment.

We hope that in the near future the demand for electric cars will increase and, as a result, our country will provide citizens with the necessary resources and together we will be able to reduce air pollution and the environment as a whole.

**References:**


1. *Chto nuzhno dlya rosta prodazh elektrokarov v Rossii* [What you need to increase sales of electric cars in Russia]. URL: https://tass.ru/opinions/9697523 (date accessed: 19.04.2021).
2. *Rossiya khuzhe vsekh razvitykh stran gotova k ispol'zovaniyu elektromobiley.* [Russia is the worst developed country ready to use electric vehicles]. URL: https://www.vedomosti.ru/auto/articles/2020/09/06/838962-rossiya-elektromobilei (date accessed: 19.04.2021).
3. *Elektromobili v Rossii v 2021 godu – chego stoit i chego ne stoit zhdat'* [Electric cars in Russia in 2021 – what to expect and what not to expect]. URL: https://zen.yandex.ru/media/autostat.ru/elektromobili-v-rossii-v-2021-godu--chego-stoit-i-chego-ne-stoit-jdat-5fc8e3406bcad04cbc8fe7f6 (date accessed: 17.04.2021).
4. *V Rossii zapustyat pervoye seriynoye proizvodstvo elektromobiley* [Russia will launch the first mass production of electric vehicles]. URL: https://kod.ru/e-transit-soberut-v-rossii/ (date accessed: 20.04.2021).

**Список литературы:**

1. Что нужно для роста продаж электрокаров в России. URL: https://tass.ru/opinions/9697523. (Дата обращения 19.04.2021)
2. Россия хуже всех развитых стран готова к использованию электромобилей. URL: https://www.vedomosti.ru/auto/articles/2020/09/06/838962-rossiya-elektromobilei. (Дата обращения 19.04.2021)
3. Электромобили в России в 2021 году – чего стоит и чего не стоит ждать. URL: https://zen.yandex.ru/media/autostat.ru/elektromobili-v-rossii-v-2021-godu--chego-stoit-i-chego-ne-stoit-jdat-5fc8e3406bcad04cbc8fe7f6 (Дата обращения 17.04.2021)
4. В России запустят первое серийное производство электромобилей. URL: https://kod.ru/e-transit-soberut-v-rossii/. (Дата обращения 20.04.2021)

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## DIGITAL CURRENCY IN PUBLIC ADMINISTRATION

**Abstract.** This paper discusses the use of digital currencies in both domestic and interstate transactions. Special attention is paid to the advantages in circulation of such alternative currencies over traditional ones.

**Keywords:** currency, digital currency, government, financial technology, CBDC.

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# ЦИФРОВАЯ ВАЛЮТА В ГОСУДАРСТВЕННОМ УПРАВЛЕНИИ

**Аннотация.** В статье рассматривается использование цифровых валют при совершении как внутригосударственных, так и межгосударственных транзакций. Особое внимание уделяется преимуществам в обращении подобных альтернативных валют перед традиционными.

**Ключевые слова:** валюта, цифровая валюта, государство, финансовые технологии, ЦВЦБ.

In the last years with the spread of cryptocurrency a great number of governments and international economic organizations consider digital currency an excellent means of making transactions.

It is worth mentioning beforehand that despite similarities in usage, digital currency does not equate with virtual funds on one's bank card. The latter is money deposited in a certain bank account belonging to a person who, with the use of a credit card, is able to commit payments via their credit card. In this case none but the bank has hold of the money, and despite the fact that legally this sum belongs to a certain bank's customer, it has the ability to redirect available funds for its purposes. Moreover, if the bank goes bankrupt or is running low on money it may defer or completely stop paying the deposit interest. After all, it could completely disappear with all the contributors' money.

On the contrast, digital currency is much different. Unlike traditional, it is not expressed in any material equivalent and not backed by any precious metal or existing currency since its essence lies in the code, which each unit of this currency is referred to. This code is stored simultaneously on multiple devices, including the main and backup servers, if this currency is controlled by the central bank (CBDC). [1] Moreover, as Viktor Dostov, chairman of Russian Electronic Money and Remittance Association (REMA) says, "Since now banks can technically issue cashless money themselves, in theory, nothing prevents them from setting any amounts on the accounts". [2] One of the ways to prevent this is to introduce state-emitted digital currency. Therefore, like cryptocurrency, it simply cannot be stolen, tampered with, or lost.

The next advantage is versatility. As it is pointed out on the example of "digital ruble", it will be possible to pay both online and offline. [3] By excluding the mediation of private banks, it will also be possible to reduce the commission fees from every transaction and save the customers' money. Another beneficial point is privacy of deals for all market participants and simultaneous transparency for the national bank, which

both help raise the level of trust towards the said currency and make it easier for the government to calculate taxes. [1] Consequently, there's nothing that stands in the way of the user if he decides to withdraw, deposit, or make payments with digital currency.

The renowned pioneers of central bank digital currency are China and Singapore. The purposes are simple, as listed on the DCEP website: "to exceed the US dollar as the world's reserve currency; detach from commercial payment infrastructure; get off the gold standard". [4] In Singapore digital currency is backed by the Singapore dollar, whereas digital yuan is not supported by anything and thus possesses more features inherent in cryptocurrency. As of today, Chinese coin is probably the most developed digital fiat currency in the world, with tests being successfully carried out in ten largest Chinese cities.

In Russia, several steps have already been made in progress towards the introduction of a government-controlled digital currency. In October 2020 Central Bank of the Russian Federation announced the introduction of a "digital ruble", which has been designed to be equal with national currency with all positive traits of a digital currency. The future of this coin is promising, albeit requiring certain expenses for launch and ensuring of accessibility: with total estimates of around 25 billion rubles, mass surveys demonstrate the public's anticipation towards the implementation of central bank digital currency in daily life. [3]

As a result, it is obvious that progressive countries are willing to utilize cutting-edge technology that has proved to bring great benefits, and digital currency is one of them. A number of modern economists agree that it is but a matter of time when digital currency begins replacing paper currency in circulation due to its reliability, security, and simplicity of use.

**References:**


1. Grigor'ev, V. V. *Nacional'naya cifrovaya valyuta kak faktor ozhivleniya ekonomiki Rossii* [National digital currency as a factor in reviving the Russian economy]. Ekonomika. Nalogi. Pravo [Economy. Taxes. Right]. 2019. №12. № 1, pp. 30-36.
2. *Rublevyj bit. CB anonsiroval razrabotku v Rossii nacional'noj cifrovoj valyuty* [Ruble bit. Central Bank announced the development of a national digital currency in Russia]. URL: https://www.rbc.ru/newspaper/2020/10/14/5f8581669a7947769a92c4be. (data accessed: 14.05.2021)
3. *Cifrovoj rubl'* [Digital ruble]. URL: https://www.tadviser.ru/index.php/Produkt: Cifrovoj_rubl' (data accessed: 14.05.2021).
4. *DCEP – Cifrovoj yuan'* (elektronnaya valyuta Kitajskogo Narodnogo Banka) [DCEP – Digital Yuan (electronic currency of the People's Bank of China]. URL: https://dcep.ru/#zachem-kitayu-nuzhna-cifrovaya-valyuta (data accessed: 19.05.2021).


**Список литературы:**


1. Григорьев В. В. Национальная цифровая валюта как фактор оживления экономики России // Экономика. Налоги. Право. – 2019. – №12. – № 1. – С. 30-36.

2. Рублевый бит. ЦБ анонсировал разработку в России национальной цифровой валюты. URL: https://www.rbc.ru/newspaper/2020/10/14/5f8581669a7947769a92c4be (дата обращения 14.05.2021)
3. Цифровой рубль URL: https://www.tadviser.ru/index.php/Продукт:Цифровой_рубль (дата обращения 14.05.2021).
4. DCEP – Цифровой юань (электронная валюта Китайского Народного Банка). URL: https://dcep.ru/#зачем-китаю-нужна-цифровая-валюта (дата обращения 19.05.2021).

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## CONTROL REGULATIONS OF ECONOMIC ACTIVITY ON THE MOON AND OTHER CELESTIAL BODIES

**Abstract.** The article is devoted to the study of the general provisions of the control regulation on the Moon and celestial bodies. The question of the legal validity of certificates for economic activity on the Moon and celestial bodies is raised.

**Keywords:** space law, Outer Space Treaty, the Moon Agreement, “Lunar Embassy”.

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## НОРМАТИВНО-ПРАВОВОЕ РЕГУЛИРОВАНИЕ ХОЗЯЙСТВЕННОЙ ДЕЯТЕЛЬНОСТИ НА ЛУНЕ И ДРУГИХ НЕБЕСНЫХ ТЕЛАХ

**Аннотация:** Статья посвящена исследованию общих положений правового регулирования Луны и небесных тел. Затрагивается вопрос о юридической силе сертификатов на хозяйственную деятельность на поверхности Луны и небесных телах.

**Ключевые слова**: космическое право, договор по космосу, соглашение о Луне, «Лунное Посольство».

Today, space research and exploration are becoming more and more important and popular direction in scientific, political and other spheres of human activity. An interesting fact is that to date, space flights have been carried out privately for entertainment or educational purposes, which leads to speculation about who owns outer space, whether it is possible to buy a plot on the Moon, and so on, which determines the relevance of the present paper.

The international legal regime of outer space and celestial bodies is defined by the Outer Space Treaty of 1967, which contains "the fundamental principles of the states' activities in outer space and the norms that directly characterize its legal regime. The States parties to the Treaty shall carry out activities for the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interests of maintaining international peace and security and promoting international cooperation and mutual understanding (art. III)" [1]. "Outer space, the Moon and other celestial bodies are not the subject to national appropriation, either by proclaiming sovereignty over them, by use or occupation, or by other means" (art. II) [1]. An identical provision is recorded in Article 11 of the Agreement on the Activities of States on the Moon and Other Celestial Bodies of 1979. "These territories are the property of all the humankind, and their exploration and use are carried out for the benefit and in the interests of all countries, regardless of their economic or scientific development degree. The results of activities related to the exploration and use of outer space are also the property of all the humankind" [1].

At the same time, space and celestial bodies cannot be considered a "common thing" or "common property" of the humanity. They are only in its general use.

Based on the Outer Space Treaty of 1967, we will analyze the incident of 1980, when the citizen of the United States of America, Denis Hope, after studying the Outer Space Treaty of 1967, and article II of this treaty, in particular, which states/declares that "outer space, including the Moon and other celestial bodies, is not the subject to national appropriation", came to the conclusion that it is possible to assign celestial bodies, including the Moon, to private ownership. Thus, Denis Hope proclaimed the Lunar Republic, founded the company "Lunar Embassy" [2] and began to sell land on the Moon and other celestial bodies around the world. In Russia, Hope's business is officially represented by two legal entities: the Lunar Embassy and the Lunar Consulate. The websites of these organizations explain that Hope "legally registered ownership of the Moon, Mars, Venus and other astronomical bodies in the Solar System, except for the Earth and the Sun". When buying a plot on the Moon, you can get several types of documents (sometimes for a fee): "Certificate of ownership", "Lunar Constitution", "Map of the Moon" and "Lunar Passport". To date, for about 4 million inhabitants of the Earth from 180 countries of the world have become owners of foreign land plots, among Russians – 20 thousand people according to 2019 [3].

Dennis Hope was not the first person who staked claim on the lunar territories. Thus, back in 1937, the resident of Georgia Linsday claimed all the planets in space. In the 1940s, there were numerous requests to the Land Administration for lunar sites.

Consider another fact. In 2000, an American called Gregory Nemitz declared the asteroid Eros. He did it in a very original way: when the NASA spacecraft landed on an asteroid, Nemitz demanded to pay him a parking fee on his asteroid in the amount of $20 for 100 years. The case went to trial, where Nemitz, however, was unable to convince the judge, who nevertheless took the matter seriously.

A similar lawsuit was filed by Canadian Sylvio Langvein in 2012, saying that he wants to collect planets and prevent China from seizing space bodies. As a result, the judge was forced to reject the proactive plaintiff.

Thus, according to the "Outer Space Treaty", "no country has the right to report a violation of its sovereignty if someone implements a landing on the moon or implements the launch of an artificial satellite into space". [4] Note the fact that according to some lawyers, this prohibition does not apply to private appropriation. That is, the Outer Space Treaty of 1967 does not contain a literal ban on the acquisition of ownership of the Moon. Actually, this omission in the law was referred to by Denis Hope.

On April 6, 2020 Donald Trump issued a decree on the commercial development of the Moon and other celestial bodies. In fact, the document establishes the unique right of Americans to use the resources of outer space. "Outer space is a legally and physically unique domain of human activity, and the United States does not view it as a global commons", noted in the decree [4].

Earlier, Trump repeatedly called the development of the Moon a priority in the United States' space policy. In March 2019, he demanded "at all costs" to send Americans to the moon within the next five years.

The legal status of the Moon and the possibility of using its resources at the international level are not fully clear. The 1967 Outer Space Treaty, which is the basis of international space law, only prohibits the deployment of weapons on the Moon and the declaration of sovereignty over any part of it, but does not regulate the commercial use of the Earth's satellite resources. But, it should be noted that in 2019, the International Court of Justice, followed by the US State Department, made statements according to which none of the earthlings has the right to violate the 1967 Outer Space Treaty, since any space object is a non – national property. Therefore, no individual who necessarily has some kind of citizenship on Earth can claim sectors of the Moon or Mars, as well as other planets, satellites, asteroids, and even stars.

To summarize the main points of research, authors can conclude that all certificates confirming the purchase of any space objects, from a legal point of view, have no validity. First of all, this is a unique sample of original souvenir products.

Today, both at the State and international levels, attempts to challenge the above-mentioned legal acts on outer space are resolved peacefully. The documents are discussed and signed by all countries unanimously, being that there is no practical sense in challenging them. The current space laws are mostly opposed by individuals, but they always lose.

**References:**

1. *Ofitsial'nyy sayt MID RF. Dogovor o printsipakh deyatel'nosti gosudarstv po issledovaniyu i ispol'zovaniyu kosmicheskogo prostranstva, vklyuchaya Lunu i drugiye nebesnyye tela.* URL: https://www.mid.ru/predotvrasenie-gonki-vooruzenij-v-kosmose/-/asset_publisher/wD2rNsftQhho/content/id/609136 [Official site of the Russian Foreign Ministry. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies]. (date accessed: 20.04.2021)
2. *Lunnoye posol'stvo v Rossii.* URL: http://www.luna.ru [Lunar Embassy in Russia]. (date accessed: 22.04.2021)
3. *U kogo uzhe yest' uchastki.* URL: http://www.luna.ru [Who already have plots]. (date accessed: 22.04.2021)
4. The Artemis Accords: One Small Step for Space Law? URL: http://opiniojuris.org/2020/05/08/the-artemis-accords-one-small-step-for-space-law/ (date accessed: 22.04.2021)

**Список литературы:**

1. Официальный сайт МИД РФ. Договор о принципах деятельности государств по исследованию и использованию космического пространства, включая Луну и другие небесные тела. URL: https://www.mid.ru/predotvrasenie-gonki-vooruzenij-v-kosmose/-/asset_publisher/wD2rNsftQhho/content/id/609136 (дата обращения: 20.04.2021)
2. Лунное посольство в России. URL: http://www.luna.ru (дата обращения: 22.04.2021)
3. У кого уже есть участки. URL: http://www.luna.ru (дата обращения: 22.04.2021)
4. The Artemis Accords: One Small Step for Space Law? URL: http://opiniojuris.org/2020/05/08/the-artemis-accords-one-small-step-for-space-law/ (дата обращения: 22.04.2021)

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## GAS SUPPLY LOGISTICS IN THE REGIONS OF THE RUSSIAN FEDERATION

**Abstract.** The paper considers logistical issues aimed at providing natural and liquefied gas to Russian regions in order to reduce the cost of energy carriers for the population. The problems of development of new gas fields in terms of logistics and economics are considered.

**Key words:** logistics advantage, gasification, energy carrier, logistics solution, regional needs, economic efficiency.

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## ЛОГИСТИКА ГАЗОВОГО ОБЕСПЕЧЕНИЯ В РОССИЙСКОЙ ФЕДЕРАЦИИ

**Аннотация.** В работе рассматриваются логистические вопросы, направленные на обеспечение регионов РФ природным и сжиженным газом, с целью снижения стоимости энергоносителя для населения. Рассматриваются проблемы освоения новых месторождений газа с точки зрения логистики и экономики.

**Ключевые слова:** логистическое преимущество, газификация, энергоноситель, логистическое решение, потребности регионов, экономическая эффективность.

One of the priorities and important directions of the Russian Ministry of Energy is the development of gas supply and gasification systems. Gazprom, the largest energy company in the world, has the world's largest natural gas reserves (16 % of the world's total gas reserves and 71 % of Russian reserves) and is responsible for implementing

this strategy. “Gazprom is also the leader in gas production, accounting for 12 % of global production and 68 % of Russian production”.

PJSC Gazprom is actively developing activities for the gasification of Russian regions, which should provide an economically feasible, the highest quality level of gasification of territories, meet the ability to pay for the resource, improve living conditions and quality of life of the population, as well as increase the economic potential of Russian regions.

PJSC Gazprom is an active participant in global gas field development projects. Currently, one of these projects is the Shtokman gas condensate field. It was found in the Barents Sea, six hundred kilometers from the city of Murmansk to the northeast. Design and survey work carried out over several years proved high economic efficiency of the field development and exploitation. According to the given estimates, the projected lifetime of the field is more than 50 years, the planned volume of natural gas production – 90 billion m3 per year [1].

In order to select the optimal logistical solution for the selection of gas pipeline routes from the Shtokmanovskoye field, several options were considered. The route Shtokmanovskoye field – Teriberka (Murmansk region) – Volkhov (Leningrad region) was chosen. The logistical advantage of this route was determined based on the analysis of technical and economic indicators, which are characterized by the following indicators: the shortest distance from the field to the point of connection to the existing gas supply system, which is located in areas with developed infrastructure, both social and industrial. The route will run close to settlements and industrial facilities of the northern regions – Murmansk Oblast, the Republic of Karelia and Leningrad Oblast – so this logistical solution will ensure minimum investment in the gas pipeline [2].

The logistic solution in selecting the route should take into account not only the economic efficiency of the project, but also ensure safety issues. This project envisages a set of measures to ensure the preservation of the Murmansk region’s water ecosystem, taking into account the proximity of the gas pipeline to the Kola nuclear power plant and other mining enterprises. The proximity of hazardous industrial facilities increases the level of seismic and explosion hazard of the gas pipeline, so it is necessary to minimize environmental problems and ensure the inadmissibility of accidents both during the construction period and in the future operation of the gas pipeline.

Another logistical advantage of selecting the above route is reducing the dependence of the Murmansk Oblast on imported fuel, as well as eliminating the need to use nuclear power and expanding the capacity of the Kola Nuclear Power Plant.

It should be emphasized that the development of the Shtokman gas condensate field will also contribute to solving social and economic problems of the affected regions of the Russian Federation:

- strengthening of the defense complex of Murmansk and St. Petersburg by creating platforms as well as equipment. Murmansk and St. Petersburg by creating platforms and equipment;
- improving the quality of technologies in the gas industry;
- supply of one of the cheapest energy resources to Murmansk and Arkhangelsk oblasts and the Republic of Karelia;

- reduction of dependence of the Russian regions on the other types of fuel;
- enhancement of gas availability in the Russian regions, which are already gasified;
- increasing the population employment and the level of provision with gas;
- increase in the number of new jobs;
- lower social tension.

Let us consider the cost of resources used for heating systems in gasified and non-gasified regions of the Russian Federation. As an example, let us take the Murmansk and Leningrad oblasts. Most municipalities in the Murmansk Oblast use coal or fuel oil as a resource for heating.

Pursuant to Resolution No. 57/7 of the Tariff Regulation Committee for Murmansk Region dd. 18.12.2020, tariffs for heat energy consumers (population) (coal as the energy carrier) in Murmansk were set at the rate of 2927.99 RUB per 1 Gcal, and for heat energy consumers (population) (fuel oil as the energy carrier) – 3364.36 RUB per 1 Gcal.

At the same time according to the Order of Saint-Petersburg Committee on Tariffs № 255-r of 18.12.2020 the tariffs for energy carrier (gas) in amount of 6.56 RUB per 1 m3 for those consumers (population), who have an opportunity to use main pipeline natural gas, were set. The same tariff for natural gas is established for the population of the Leningrad Region (Order of the Committee on Tariffs and Pricing Policy of the Leningrad Region № 76-L of 31.07.2020).

For example, let's calculate the amount of payment for heating for consumers in the Murmansk Oblast and Leningrad Oblast for a 2-room apartment with an area of 52 m2. Calculation will be made on the basis of standards of consumption of communal services for gas and heating with another energy carrier, established by Order of the Committee of the energy complex and housing and communal services of the Leningrad region № 3 of 16.05.2012. Standard consumption of communal services for gas supply for owners living in apartment buildings: heating 1 m2 of natural gas is 8.2 m3. Thus, the payment for the heating service of a 2-room apartment with the area of 52 m2 will be 2,797.18 rubles for the residents of the Leningrad region.

To calculate the payment for the heating service for consumers in the Murmansk region, we determine the consumption standard based on the Order of the Ministry of Energy, Housing and Communal Services of the Murmansk region № 34 of 11.03.2013 (as amended on 5.03.2019) – 0.029 Gcal per 1 m2 of area. Thus, the payment for the service of heating a 2-room apartment for the population of Murmansk will be 5073.45 rubles.

The implementation of the gasification program, in particular, for the Murmansk region could solve many problems both on a regional scale – the withdrawal from fuel oil dependence, and for each individual resident of the region.

The deadline for the start of Shtokman field development has been periodically postponed due to the scale and complexity of the project, as well as the ways to sell the produced gas. But in February this year, the government approved a program for the development of liquefied natural gas production in Russia. It stated that by 2035 a plant

for liquefaction of gas produced at the Shtokman gas condensate field is planned to be commissioned [3].

**References:**


1. *Informaciya PAO "Gazprom". "SHtokmanovskoe mestorozhdenie" 2021 god. O "Gazprome"* [Information PJSC Gazprom "Shtokman field" 2021. About "Gazprom"]. URL: https://www.gazprom.ru/projects/shtokmanovskoye/ (accessed 20.04.2021).
2. Alifirova, E. *SHtokman ne zabyt. Neftegaz* [Shtokman is not forgotten. Neftegaz]. 2021. №2. URL: https://neftegaz.ru/news/spg-szhizhennyy-prirodnyy-gaz/665136-shtokman-ne-zabyt-gazprom-planiruet-vvesti-mestorozhdenie-v-ekspluatatsiyu-v-2029-g/ (accessed 20.04.2021).
3. *Informaciya RBK. "Gazprom zaplaniroval vozrodit' svoj SPG – dolgostroj v Arktike" 2021 god. "Gazprom" zaplaniroval vozrodit' svoj SPG-dolgostroj v Arktike. Biznes: RBK* [RBC information "Gazprom plans to revive its LNG – long term construction in the Arctic" 2021. URL: https://www.rbc.ru/business/22/03/2021/6058e6579a794790b98c7439 (accessed 20.04.2021).


**Список литературы:**


1. Информация ПАО «Газпром» «Штокмановское месторождение» 2021 год. О «Газпроме». URL: https://www.gazprom.ru/projects/shtokmanovskoye/ (дата обращения 20.04.2021).
2. Алифирова Е. Штокман не забыт. Нефтегаз. 2021. №2. URL: Штокман не забыт. Газпром планирует ввести месторождение в эксплуатацию в 2029 г. (neftegaz.ru) (дата обращения 20.04.2021).
3. Информация РБК «Газпром запланировал возродить свой СПГ – долгострой в Арктике» 2021 год. «Газпром» запланировал возродить свой СПГ-долгострой в Арктике. Бизнес: РБК. URL: https://www.rbc.ru/business/22/03/2021/6058e6579a794790b98c7439 (дата обращения 20.04.2021).

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## THE CHANGING SKILL SET FOR SUCCESSFUL EMPLOYMENT

**Abstract.** The article addresses the issue of new trends on the labor market in a post-pandemic world. It also highlights a change in the hard, soft and digital skill sets required to secure a stable job.

**Keywords:** labor market, unemployment, hard skills, soft skills, requirements for employees.

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## МЕНЯЮЩИЙСЯ НАБОР НАВЫКОВ ДЛЯ УСПЕШНОГО ТРУДОУСТРОЙСТВА

**Аннотация.** В статье рассматривается вопрос о новых тенденциях на рынке труда в мире после пандемии, а также изменение в структуре «жестких», «мягких» и цифровых навыков, необходимых для обеспечения стабильной работой.

**Ключевые слова:** рынок труда, безработица, «жесткие» навыки, «мягкие» навыки, требования к работникам.

The COVID-19 pandemic had a profound impact on the global economy, which entailed changes in the labor market. The article is aimed at discussing the altering requirements for successful employees in terms of acquiring new hard, soft and digital skill sets.

One of the main tendencies in the labor market is increasing unemployment. On the one hand, about 500 million people in the world lost their job due to the pandemic and find it difficult to get a new one [1]. On the other hand, companies also face the problem of finding qualified employees. A high unemployment rate usually implies a lot of job seekers per vacancy. However, in this crisis the situation is different: a lot of

people are not looking for a new stable job in the hope that they will have the opportunity to restore their places later, after the pandemic. Many older people retired early because of COVID-19. They contribute to the unemployment level, and the number of unemployed for today is historically high. In an ordinary crisis, the level of goods consumption falls, while the use of services remains the same. This time everything is different: due to the need for social distancing, most job losses occurred in the service industry [1].

Other trends in the labor market include companies paying more attention to gender equality, offering social insurance to their employees and introducing new requirements for the workforce. There is an increasing demand for such professions as a financial analyst, a specialist in sales and marketing, a software developer and programmer, a product creator and designer and a client manager [1].

Apart from the economic crisis, one of the main factors that made employers reconsider their requirements for future employees was the need to switch to remote work. The pandemic forced enterprises to admit that a large majority of their workforce can perform their duties efficiently from home. According to the Superjob study, about 70% of employees work much more productively outside the office [2]. Also, 97 % of Beeline managers note that the efficiency of work in the work-from-home model has not decreased. As a result, "VimpelCom", which provides services under the Beeline brand, has transferred 56 % of office employees to remote work [3].

The set of skills and abilities required of an employee in these working conditions ranges from time management skills to digital skills. With the work-from-home model, it is important for employees to differentiate between "working time" and "personal time" [4], i.e. independently organize work schedule, without being distracted by household chores. In addition, measures should be taken against procrastination: turning off notifications and blocking individual sites for 5-7 hours during the work. There are various programs and methods of time management, including "the getting things done" technique, which implies noting down the tasks at hand, breaking them down into smaller assignments and setting time limits for accomplishing them, thus improving personal productivity.

The remote mode of work and the increasingly competitive professional environment and technological advancement make it necessary to constantly improve one's digital skills. For the employee to remain in demand, it is absolutely important to be able to freely use basic communication programs such as Google + Hangouts, Skype, Zoom [5], to be ready to interact with the team remotely by participating in group chats, including "off topic" chats, through video conferences (since brainstorming is more effective if conducted orally) and virtual out-of-office meetings, for example, online game tournaments. It is vital both for generating ideas and socializing in the company. The digital skill set also includes the employee's ability to ensure security of the company's data and carefully check all the programs and files they are going to work with. If the company's data are stored on the Internet, it is best to use smart-cards or USB-tokens that can protect confidential information from intruders.

Another interesting trend in the labor market of the future is the idea of continuing education, or "life long learning" [5]. This concept is not necessarily related to an advanced training within a single speciality. It also includes learning another profession and acquiring new hard skills. There are certain hard skills that are in high demand and that can help you secure a job. Firstly, the skills of working with a blockchain – a big data base that collects information together in groups, also known as blocks. The demand among employers is associated with a relatively small number of specialists in this area. Moreover, there is very little competition. Secondly, the ability to work with cloud computing. Many companies today are created and run in the cloud and need people to help manage the technical architecture, design, and implementation of cloud systems. Thirdly, there is a high demand for analytical thinking. Work with data and analytics are another trend in recent years. Companies need specialists who can analyze available data sets, draw conclusions and lead the company in the right direction based on information. Fourthly, the ability to use artificial intelligence, which allows computers to perform tasks that humans cannot. Fifth, having business intelligence, the importance of which is constantly growing [1].

Undoubtedly, hard skills and digital skills will always remain relevant, but in view of the big changes in the work activity, soft skills also come out on top. The pandemic has shown how changeable the world is, so the applicants and employees who were quick to adapt to the current circumstances had a competitive advantage over their rivals. That is why flexibility of the workforce is absolutely important for the development and implementation of innovative methods [5]. Also in order to adapt to remote work, employees need high motivation, concentration and attention management, which will help not burn out at work and cope with a large flow of information and tasks; creativity for finding a non-standard solution; cross-cultural skills and emotional intelligence for interacting with people from different subcultures and generations.

Undoubtedly, due to the highlighted changes in the labor market, the future workplace will look much different from the pre-pandemic model. Employees will have to adapt to the altered conditions and develop their hard, soft and digital skill sets in order to be in demand. Despite all the problems, the current situation can serve as a springboard for achieving better results in one's career. Regular professional development will help overcome uncertainty and instability.

**References:**


1. World Employment and Social Outlook // International Labour Organisation. URL: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_734455.pdf (date accessed: 24.04.2021).
2. *Issledovaniya rekrutingovogo portala Superjob.ru.* URL: https://spb.superjob.ru/research/ (date accessed: 25.03.2021).
3. *Perspektivy` udalennoj raboty` v Rossii glazami vladel`cev kompanij i sotrudnikov // Issledovanie Webinar Groupi, "Levada Centra".* URL: https://webinar.ru/blog/wp-content/uploads/2020/06/Research_of_remote_work_in_Russia_Webinar-Group.pdf (date accessed: 25.03.2021).

4. *Ob e`ffektivnoj udalennoj rabote: rabochee i lichnoe vremya.* URL: https://habr.com/ru/company/jugru/blog/492714/ (date accessed: 23.03.2021).
5. *Postpandemicheskoe budushhee: kakix izmenenij ozhidat` dlya rabotodatelej i soiskatelej i kak k nim podgotovit`sya.* URL: https://blog.trud.com/blog/2020/09/01/postpandemicheskoe-budushee-kakie-izmenenija-dlja-rabotodatelei-i-soiskatelei-proisoidut/ (date accessed: 24.03.2021).

**Список литературы:**

1. World Employment and Social Outlook // International Labour Organisation. URL: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_734455.pdf (дата обращения: 24.04.2021).
2. Исследования рекрутингового портала Superjob.ru. URL: https://spb.superjob.ru/research/ (дата обращения: 25.03.2021).
3. Перспективы удаленной работы в России глазами владельцев компаний и сотрудников // Исследование Webinar Groupи, «Левада Центра». –2020. – С. 33. URL: https://webinar.ru/blog/wp-content/uploads/2020/06/Research_of_remote_work_in_Russia_Webinar-Group.pdf (дата обращения 25.03.2021).
4. Об эффективной удаленной работе: рабочее и личное время. URL: https://habr.com/ru/company/jugru/blog/492714/ (дата обращения: 23.03.2021).
5. Постпандемическое будущее: каких изменений ожидать для работодателей и соискателей и как к ним подготовиться. URL: https://blog.trud.com/blog/2020/09/01/postpandemicheskoe-budushee-kakie-izmenenija-dlja-rabotodatelei-i-soiskatelei-proisoidut/ (дата обращения: 24.03.2021).

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## TWO-SIDED MARKET APPLICATION TO UNIVERSITY STUDENT DISTRIBUTION

**Abstract.** Now many people criticize the current system of distribution of applicants across universities, but from a mathematical point of view, such system is close to ideal. The 2012 Nobel Prize was awarded for exploring this and other issues related to two-sided markets. The report will deal with the approaches and algorithms used in this problem and the practical application of this theory.

**Keywords:** two-sided market, Gale–Shapley algorithm, stable matching, blocking pairs, preferences, mathematical model.

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# ПРИМЕНЕНИЕ ДВУСТОРОННЕГО РЫНКА ДЛЯ РАСПРЕДЕЛЕНИЯ СТУДЕНТОВ ПО ВУЗАМ

**Аннотация.** В настоящее время многие критикуют существующую систему распределения абитуриентов по университетам, но с математической точки зрения такая система близка к идеальной. Нобелевская премия 2012 года была присуждена за исследование этого и других вопросов, связанных с двусторонними рынками. В статье рассматриваются подходы и алгоритмы, использованные в этой проблеме, и практическое применение данной теории.

**Ключевые слова:** двусторонний рынок, алгоритм Гейла – Шепли, стабильное распределение, блокирующие пары, предпочтения, математическая модель.

The model of two-sided market is applied not only in economy but also in other areas: from telecommunications and cellular communications to donor distribution. For the formal construction and study of this of model Alvin Roth and Lloyd Shapley received in 2012 the Nobel Memorial Prize in Economics.

First, let us figure out the basic definitions. In general, the solution of this problem lies in the domain of higher mathematics.

*Two-sided market* is a market model in which there are two types of agents. This can be, for example, Men and Women, Students and Universities and others. Agents can be *matched* only with agents of the opposite type. Each agent has a *preference* for a different type of agent, which means each agent can say which of the other agents it would more like to be matched with. A *matching* is a set of links between agents. A matching is called *stable matching* if there are no *blocking pairs* for it. Let us illustrate this definition with an example.

To begin with, let us take a very brief look at Marriage Model – the most famous and classical model of two-sided market. There are two sets: Men and Women:

$$M = \{m_1, m_2, \dots, m_n\}, W = \{w_1, w_2, \dots, w_n\} \quad (1)$$

And a set of preferences:

$$P = \{P(m_1), \dots, P(w_n)\}, \quad (2)$$

where $P(m_i)$ is an ordered list of agents.

$w_1 \succ_{m_i} w_2$ means that for the men with the number *i* first women is preferable than second women.

$m_i \succ_{m_i} w_3$ means that for the men with the number *i* stay alone is preferable than second women.

A pair will be called *acceptable* if both the man and the woman prefer to be with each other rather than be alone. A pair is not acceptable means that one or both agents do not like their partner so much that they would rather remain alone. Matching $\mu$ consists of acceptable pairs in which agents do not repeat. If *(m, w)* is included in the matching $\mu$, then $\mu(m)$ denotes *w* and $\mu(w)$ denotes *m*. A blocking pair for the matching $\mu$ will be such a pair *(m, w)* that for each of the agents m and w this pair will be better than their pairs in the matching $\mu$, that is:

$$w \succ_m \mu(m) \; and \; m \succ_w \mu(w) \tag{3}$$

It important to say that the blocking pair is not included in the matching. Let us look at the example. There are two man and two women: $m_1$, $m_2$, $w_1$ and $w_2$. They have preferences and have already suggested matching shown in Figure 1.

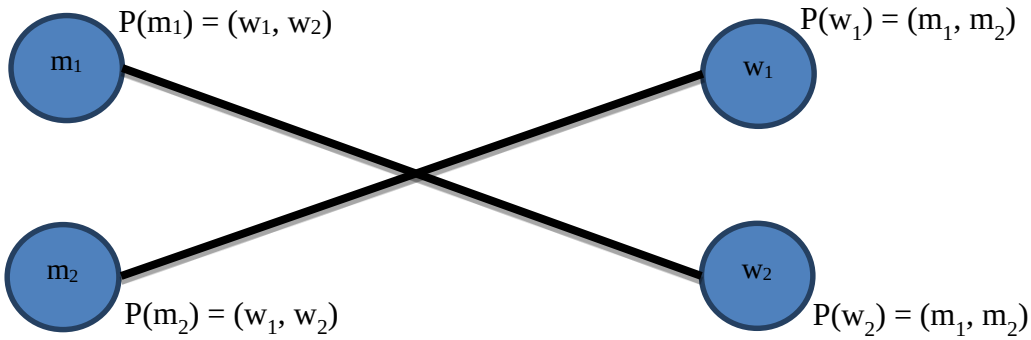


Figure 1

Consider the pair $(m_1, w_1)$. It is not included in matching, but $m_1$ prefers $w_1$ over $w_2$, and $w_1$ prefers $m_1$ over $m_2$. That means pair $(m_1, w_1)$ is blocking, since condition (3) is satisfied: $w_1 \succ_{m_1} w_2 \; \& \; m_1 \succ_{w_1} m_2$

The Gale-Shapley algorithm is used to find a stable matching. It will be described in general terms for the Marriage model, but in practice we will look at the model of distribution among universities. At the first step, each man proposes to the girl who goes first on his list of preferences. Each girl may have a few proposals or may not have even one. Then each girl on the list of candidates chooses the most preferable man and tells him "maybe", while to the rest she answers "no". At the next step, the "rejected" men make new proposals to the next girls on their lists of preferences or remain alone, if it is more preferable for them. Girls compare their current candidate (if any) with new ones and make a choice. This happens until there are no "free" men left [1].

The proof of stability is almost trivial. Let us prove this statement by contradiction. Let there be a blocking pair. Then a man from this pair had to propose to a girl from this pair, but since he is not with her, it means he was rejected, which means now this girl is with a more preferred partner. This is a contradiction, so there are no blocking pairs, which is what we had to prove.

Now we will expand this model to applicants and universities. The difference is that instead of men, we have applicants who can still go to one university, and instead of women, universities that can now accept more than one student. So, matching can have more than one pair with the same university, but the rest remains the same. Let us consider the work of the expanded algorithm using an example.

We have 3 universities with 2 places in each and 7 applicants. The preferences of universities and applicants are shown in Fig.2:

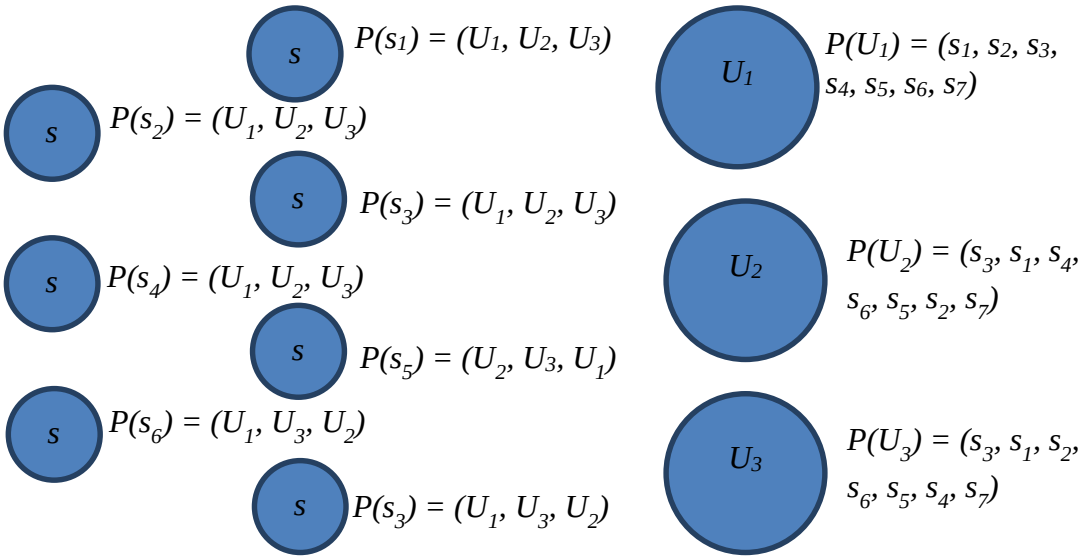


Figure 2

At the first step of the algorithm, all applicants submit documents to the institution of higher priority for them. So, all students except $s_5$ go to the $U_1$, and the $s_5$ goes to $U_2$. Of all the applicants, $U_1$ chooses students $s_1$ and $s_2$. $U_2$ considers the candidacy of $s_5$. At the next step, all "free" students apply to the university that is in second place on their lists of preferences. So $s_3$ and $s_4$ submit documents to $U_2$ and $s_6$ and $s_7$ submit documents to $U_3$. $U_2$ decides to keep $s_3$ and $s_4$ and reject $s_5$'s application from the previous step. $U_3$ accepts all applicants. At the third step, the "free" student $s_5$ applies to $U_3$, which accepts it and rejects $s_7$'s application. He applies to $U_2$, but he is denied, since $s_3$ and $s_4$ are more priority. $S_7$ remains without a university. This is not surprising, since it is the last one in the preferences of all universities, and the number of vacant places is less than the number of applicants [2].

The current system works in a more or less similar way: applicants prioritize universities, universities form priorities given the Unified State Exam (EGE) scores. The main difference is that there are only two waves. The real system is complicated, for example, with quotas, but for such cases there are varieties of algorithms. This system, of course, would probably be better if there were more than two waves of enrollment, but this would significantly complicate the bureaucratic issues. Thus, we can see on the example of this model how theory and practice are closely intertwined, giving good results.

**References**

1. Zhelesova, E., Izmalkov, S., Sonin, K., Khovanskaya, I. Two-Sided Markets: Theory and Applications (Nobel Memorial Prize in Economics 2012). *Voprosy Ekonomiki*. 2013; (1), pp. 4-26. (In Russ.)
2. Roth, A. E., Sotomayor M. The College Admission Problem Revisited // Econometrica. 1989. Vol 57, pp. 559-570.

**Список литературы**

1. Железова Е. Б., Измалков С. Б., Сонин К. И., Хованская И. А. Теория и практика двусторонних рынков (Нобелевская премия по экономике 2012 года) // Вопросы экономики – №1. – 2013. – С. 4-26.
2. Рот А.Е., Сотомайор М. Новый взгляд на проблему приема в колледж // Econometrica. – 1989. – Т. 57. – С. 559-570.

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## WHAT BUSINESS WILL BE POPULAR AFTER THE PANDEMIC?

**Abstract.** The pandemic has upended the economy. Many businesses have gone bust, but some are only gaining popularity. The article provides a forecast for the future about what types of business will be in demand in the future after the pandemic.

**Keywords:** business, types of business, pandemic, coronavirus, economy, survey.

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## КАКОЙ БИЗНЕС БУДЕТ ПОПУЛЯРЕН ПОСЛЕ ПАНДЕМИИ?

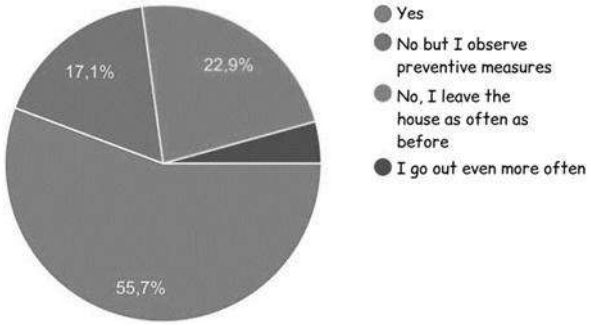
**Аннотация.** Пандемия коронавируса перевернула экономику. Многие виды бизнеса разорились, однако некоторые только набирают популярность. В

статье дается прогноз на будущее о том, какие виды бизнеса будут востребованы после пандемии.

**Ключевые слова:** бизнес, виды бизнеса, пандемия, коронавирус, экономика, опрос.

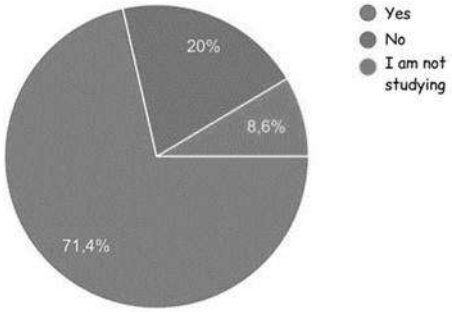
The COVID-19 pandemic has changed people's lives dramatically. Absolutely everyone sure that people's lives will never be the same: the economic and social spheres are changing and will continue to change. Many enterprises have suffered huge losses, some had to close their production because of the inability to increase profits, which leads to the impossibility for the company to exist. However, some types of business managed to adapt to the new changes in the economic sphere, were able to come up with workarounds so as not to lose sales and survive in the market. It is possible that after the pandemic, this business expects growth and popularity. The purpose of this work is to identify business areas that will be in demand after the coronavirus pandemic, based on people's preferences.

Obviously, the main task of any business is to make a profit. However, there are still a few criteria that you should rely on when starting a business after the pandemic. Before choosing a particular niche, it is worth considering the following factors: demand, uniqueness, digitalization [1]. In the era of the coronavirus, digitalization plays an important role. This point has become even more important in the conditions of modern life of people around the world. The outbreak of a new virus at some point "closed" people to their homes. According to a survey of 70 people aged 16-40 years, 56 % of them noted that they began to stay at home more often after the end of strict quarantine restrictions. As a result entire daily life of people is limited to the place of residence and gadgets. To find out the news in the world, to work, to study – you needed a computer, phone, tablet and so on.



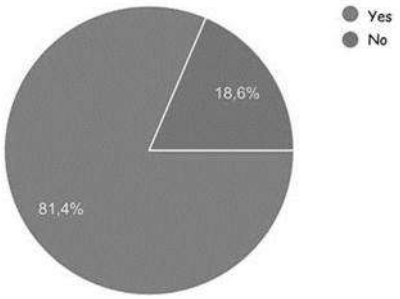

Pic. 1. Are you more likely to be at home after the end of the lockdown compared to the period when the coronavirus was not yet known?

In this regard, the respondents were asked a question related to their studying during the lockdown period. A survey showed that 70 % of the educational institutions in which people study used distance technologies. They most often used such applications as Skype and Zoom for conducting classes online. Most of the business that did not close down switched to the online or remote work and they used such programs too. This allows us to identify the first type of business – the creation of applications and sites for online communication.



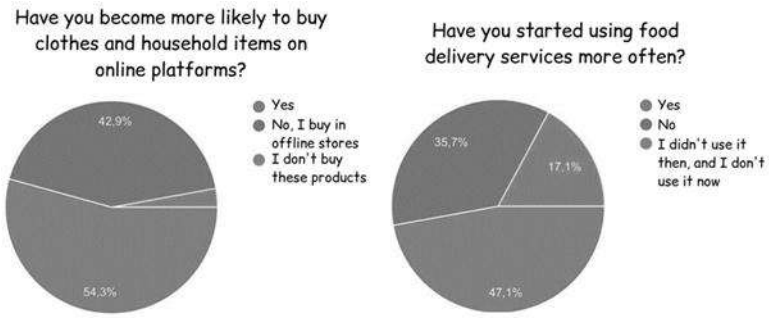

Pic. 2. Does your educational institution use distant technologies?

Many people took training courses, such as cooking or painting, because it was boring to sit at home. The self-isolation regime confirmed that today in order to gain new knowledge it is not necessary to be physically present at courses, at school or at university. This means that schools, private teachers and coaches, using modern technology, will be able to attract students from any part of the world. 81 % of the respondents used additional education services during the pandemic. This allows us to identify the second type of business in our scientific research – online courses. The article of World Economic Forum states that some research shows that on average, people retain 25-60 % more material when learning online compared to only 8-10 % in a classroom. If we also take into account that online courses are cheaper than offline, then the demand will constantly grow.




Pic. 3. Did you use additional education services during the lockdown?

Director of the Russian Association of Electronic Communications, highlighted the digital platforms that have become the most popular during the pandemic. Among them are also listed online stores [2]. Placing products online on certain sites allows us to increase the profit from sales, because we only need to spend money almost on storing goods in a warehouse and high-qualified managers [3]. In this regard, respondents were asked to answer questions related to their online purchases. The survey confirms that 55 % of people have become more likely to buy something in online stores, 47 % have become more likely than before to buy food. This leads to the following the third and fourth types of business, namely delivery services and trade in food or ready-made products. They are very interrelated, as products are delivered using delivery services, so it’s better to highlighted them together.



Pic. 4. Questions related to online purchases.

The survey also revealed one business line that is less likely to be in demand after the pandemic. During the quarantine, people have the opportunity to visit excursions and exhibitions online. However, as the survey showed, only almost 16 % used this service, and the remaining 84 % did not. Thus, this type of entertainment will not find its place in the market, because people still appreciate being outside the walls of the house, they want to attend all events live and see with their own eyes.

By analyzing the preferences of people and their new habits formed in connection with the pandemic we can guarantee the further development of those types of businesses that, firstly, will simplify people's lives in terms of saving time, and secondly, will reduce the risk of contracting the virus due to the fact that these business areas will allow you to work, study and generally survive without leaving home.

**References:**

1. Gordeeva, E. V. Small business after the coronavirus pandemic // Journal of Economy and Business, 2020, pp. 80-83.
2. *Kakoy biznes otkryt' posle koronavirusa? Chto stanet aktual'no, a chto ne ochen'?* [What business to open after the coronavirus? What will become relevant and what will not be very important?]. Banks Today. URL: https://bankstoday.net/last-articles/kakoj-biznes-otkryt-posle-koronavirusa
3. *Kakoy biznes budet vostrebovan v Rossii posle pandemii.* [What business will be in demand in Russia after the pandemic]. URL: https://hussle.ru/kakoj-biznes-budet-vostrebovan-v-rossii-posle-pandemii/

**Список литературы:**

1. Гордеева Е. В. Малый бизнес после пандемии коронавируса // Journal of Economy and Business. – 2020. – С. 80-83.
2. Какой бизнес открыть после коронавируса? Что станет актуально, а что не очень? // Banks Today. URL: https://bankstoday.net/last-articles/kakoj-biznes-otkryt-posle-koronavirusa
3. Какой бизнес будет востребован в России после пандемии. // Hussle. URL: https://hussle.ru/kakoj-biznes-budet-vostrebovan-v-rossii-posle-pandemii/

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